PERIODONTAL NUMBER—SECTION 1

33 SEPTEMBER, 1947 No. 9

American Journal of Orthodontics and Oral Surgery

FOUNDED IN 1915

CONTENTS

ORTHODONTICS

ORAL SURGERY

Periodontal Number—Section 1

Published by THE C. V. MOSBY COMPANY, St. Louis, U. S. A.

Vol. 33, No. 9, September, 1947. American Journal of Orthodontics and Oral Surgery is published Monthly by The C. V. Mosby Company, 3207 Washington Blvd., St. Louis 3, Mo. Subscription Price: United States, Its Possessions, Pan-American Countries, $8.50; Canada, $10.00 (Canadian Currency); Foreign, $9.50. Entered as Second-class Matter January 14, 1915, at the Post Office at St. Louis, Missouri, under the Act of March 3, 1879. Printed in the U. S. A.

SEPTEMBER, 1947

Orthodontics

Office of the Editor: 8022 Forsythe Boulevard, St. Louis
Published by The C. V. Mosby Company, St. Louis

American

Journal of Orthodontics and Oral Surgery

Vol. 33 SEPTEMBER, 1947 No. 9

Original Articles

CHANGES IN THE DENTAL ARCHES AS A FACTOR IN ORTHODONTIC DIAGNOSIS

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THE orthodontist's main interest is the prevention and correction of the defects of occlusion of the dental arches. Therapy consists of directing and producing changes of these defects so as to obtain a more favorable occlusion. A better understanding of the growth and development of the arches will help us to accomplish our aims. My study of forty-eight children, who have been followed continuously from birth, may clarify some of the problems involved. These children are normal, white, and come from varied economic levels. Twenty-four have been followed from birth to 7 years of age, twenty-four from birth to 10 years. Impressions of the maxillary and mandibular arches with individual bites were taken periodically, and from these casts were made and analyzed.

My early findings have been reported; however, some of the high lights will bear repetition in order to connect previous reports with my findings to date. A few facts about the anatomy of the gum pads are essential, because some landmarks that are present at birth are also present in the children whom we treat in our practice, and may have a diagnostic value which is being overlooked. For example, the posterolateral sulcus is present at birth and persists through life. I am sure that you have observed the edentulous tissue posterior to the first molar, and no doubt you have noted a line dividing this tissue. This line in the

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Presented at the meeting of the Northeastern Society of Orthodontists, New York, N. Y., March 10, 1947.

mandible is sometimes on the crest of the ridge and follows the general arch form. In the maxilla, it runs in an oblique direction. At times the line is obscure, depending upon the stage of development. Just prior to the eruption of the second molars, an opening is created in this line. The second molar has been cited as an example, but all molars, deciduous and permanent, erupt through similar openings. The location, direction, and length of this line, which is the posterolateral sulcus, may be a factor in diagnosis. I am suggesting this in order to show the importance of a better understanding of early development.

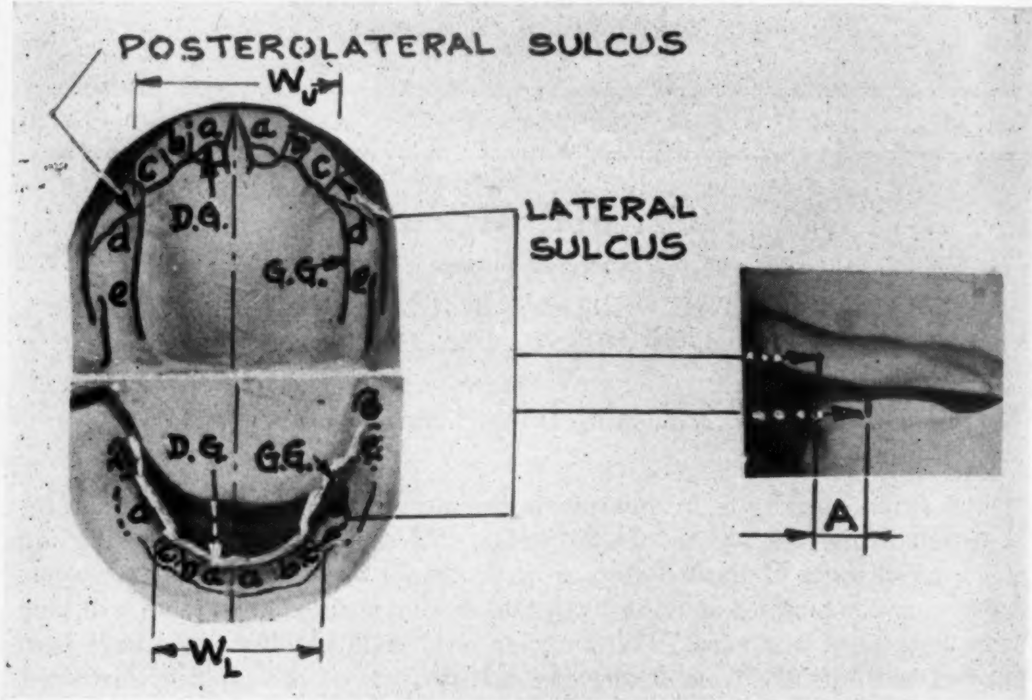

Fig. 1.—Casts at birth showing some anatomic landmarks of the gum pads and dimensions used in study. Solid lines, anatomy well defined. Dotted lines, anatomy not clearly defined. D. G., Dental groove; G.G., gingival groove; *a, b, c, d, e,* location of tooth sacs. W_U and W_L width of arch between crests of the lateral sulci. *A*, Anteroposterior dimension between lateral sulci.

Fig. 1 is a set of casts taken at birth, and shows the anatomic landmarks of the maxillary and mandibular gum pads and the dimensions studied for each series of casts. The dental groove (*D.G.*) is the result of the invagination of the epithelium into the underlying connecting tissues; the gingival groove (*G.G.*) defines the inner alveolar margin. At birth, the gum pads are clearly segmented, and the segments correspond in number to the underlying deciduous tooth sacs (*a, b, c, d, e*). The sulci between them, with the exception of the posterolateral ones, mark the position of the interdental septa. Some of the sulci and grooves present at birth become obliterated with the eruption of dentition. This is not the case with the lateral sulci, which divide the canine from the first deciduous molar segments. In the maxilla, these sulci are clearly defined from the lingual to the labial aspects and sometimes extend to a lateral frenum,

while in the mandible they can be seen on the lingual aspect only. Because they are consistently present in both jaws, they serve as landmarks for measurements. The anteroposterior dimension is designated by A, while the width of the maxillary and mandibular arches is designated by W_U and W_L, respectively.

In the newborn, there is a space between the gum pads, as there is no occlusion. Roentgenograms of the skull and measurements have been presented previously in support of this fact. As further evidence, Fig. 2 shows cross-sectional casts of the same child from birth to 3.54 years, made posterior to the canines. It is interesting to note the lack of flattening of the gum pads (*P*) when there is no occlusion (*0* and *0.34* year) and the increase of the flattened surface (*P*) in the succeeding sections (*1.06* and *1.92*) when there is occlusion.

The anterior space between the gum pads differs in form and lends itself to the following classifications (Fig. 3):

Class A, maxillary and mandibular anterior segments in their respective planes.
Class B, incisal segments higher than canine in the maxilla; in the mandible, anterior segments in the same plane.
Class C, incisal segments higher than canine in the maxilla; in the mandible, canine segments higher than incisal.
Class D, maxillary anterior segments in the same plane; in the mandible, canine segments higher than incisal.

Is there a relationship between the form of the space at birth and the occlusion of the subsequent dentition? When considering this question in reference to my group of forty-eight children, there is a suggestion that a relationship exists. The group has been divided into good and poor occlusion, as shown by their last casts. Nineteen children have a good occlusion, and twenty-nine have a poor occlusion.

In Class A (Table I), which has the largest number of children, there are twelve with good occlusion and fourteen with poor occlusion. This difference is of no importance. However, in Classes B and C there are twice as many with poor occlusion as with good occlusion, and in Class D, where there are only four children represented, one child has good occlusion whereas three children have poor occlusion. It is interesting to note that, when we combine the classes where poor occlusion is prevalent (B, C, and D), there are seven children (31 per cent) with good occlusion and fifteen (68 per cent) with poor occlusion. These figures may suggest that a child with a space of Class B, C, or D at birth is more likely to develop poor occlusion than a child in Class A.

TABLE I. COMPARISON OF SPACE AT BIRTH WITH SUBSEQUENT OCCLUSION

OCCLUSION	CLASS A	CLASS B	CLASS C	CLASS D
Good (19)	12	4	2	1
Poor (29)	14	8	4	3

In some instances, however, good occlusion has developed regardless of the form of space at birth. The casts (Fig. 3) of four children illustrate this point.

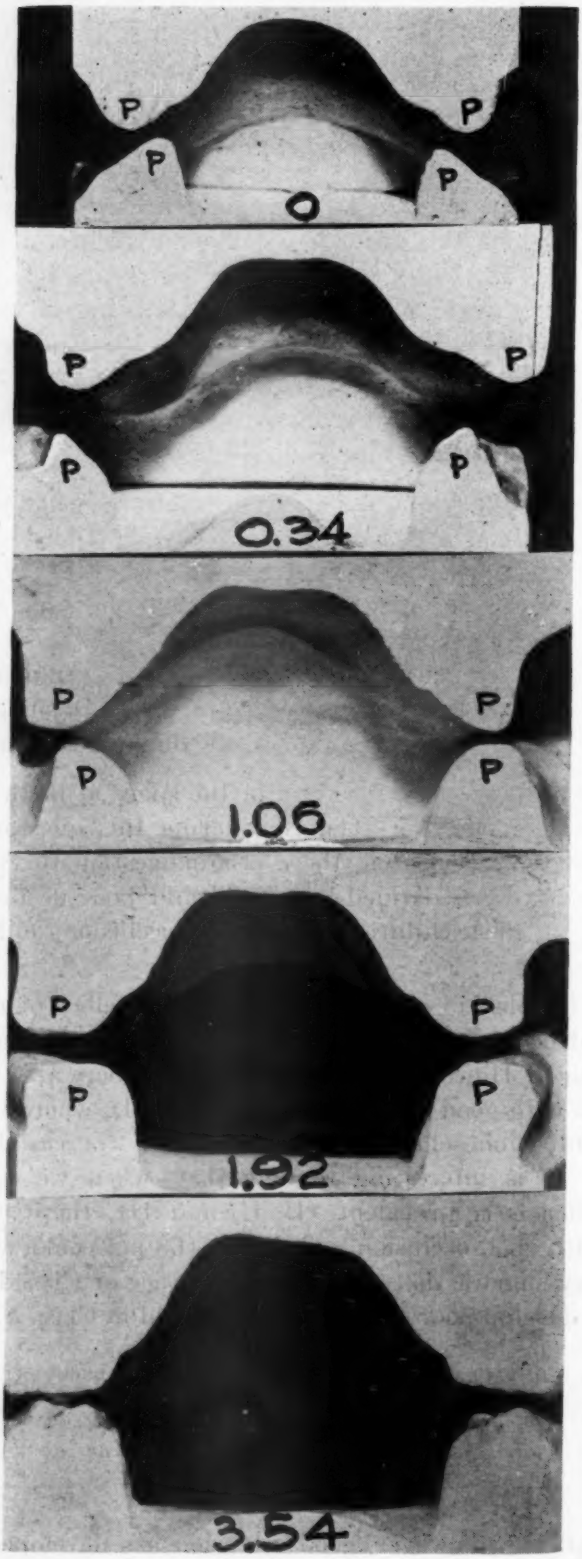

Fig. 2.—Serial cross-sections of casts posterior to canine illustrating changes in morphology of the gum pads (*P*) from preocclusion to occlusion. (Numbers represent age in years.)

On the left are the casts of the infant and on the right are the latest corresponding casts of the same child. The letters, *A, B, C,* and *D,* designate the classification of space and the numbers represent the age in years. You will note that the follow-up casts all show a good overbite irrespective of space at birth, and, in addition, they all have good molar relationship.

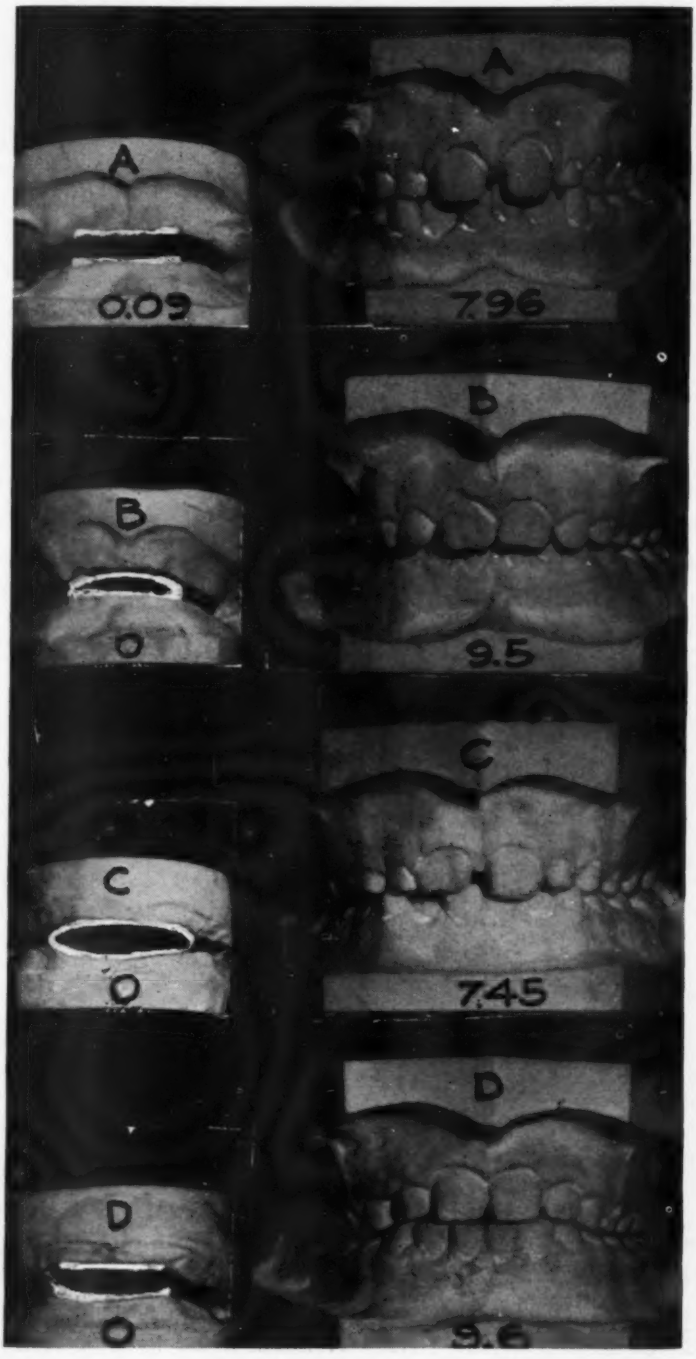

Fig. 3.—Casts of four children at birth and their corresponding latest follow-up casts. *A, B, C, D,* is the classification of anterior opening at birth. (Numbers represent age in years.)

Another finding of diagnostic value is the asymmetric development of the anterior space. I have four children who have developed in this manner; all have varied poor occlusion in their corresponding dentitions. Bernard (Fig. 4) is such an example: at 0.17 year there is a relatively symmetric opening; 0.49 year shows a change to an asymmetric opening; at 1.09 and 1.49 years, the incisors have erupted and the opening is closed; while at 5.16 and 8.1 years, there is an opening in the bite again in addition to a poor molar relationship. This evolution could be noted only by a serial study.

How does the anteroposterior dimension (*A*) at birth relate to the subsequent occlusion? The relationship of the jaws at birth is established by closing the jaws into a wax bite. It must be remembered that the mandible at this time has only a hingelike motion, and taking a bite is relatively simple. One cannot compare the taking of a bite at birth with the taking of a bite in an adult edentulous person. As stated previously, the infant has only a hingelike motion, whereas the adult has developed all the movements of the temporomandibular joint. I have taken as many as five bites on the same infant with practically no variation of position.

The distance (*A*) between the lateral sulcus of the maxilla and mandible was measured in 161 infants (Fig. 1). This dimension has a range of variation from 0 to 8 mm. and a mean value of 2.6 mm., which shows that the mandible is posterior to the maxilla in all cases at birth.

Table II classifies the group of forty-eight children, comparing the anteroposterior dimension (*A*) at birth to their subsequent occlusion. When dimension *A* ranges from 0 to 3 mm., the numbers found with good and poor occlusion are relatively equal, there being a total of fifteen good occlusions and eighteen poor occlusions. However, in the range from 4 to 8 mm., there is a larger number with poor occlusion, there being a total of three (20 per cent) with good occlusion and twelve (80 per cent) with poor occlusion. This suggests that the anteroposterior dimension (*A*) at birth may have a bearing on the occlusion of the subsequent dentition. It does not necessarily mean that the subsequent dentition will have a posterior relationship if, at birth, an extreme position of the mandible is present; but it does mean that the child may have a poor occlusion.

TABLE II. COMPARISON OF THE ANTEROPOSTERIOR DIMENSION OF DENTAL ARCHES AT BIRTH (*A*) WITH ITS SUBSEQUENT OCCLUSION

	RANGE OF DIMENSION *A* (MM.)								
Occlusion	0	1	2	3	4	5	6	7	8
Good	4	2	6	3	2	1	0	0	0
Poor	5	1	9	3	6	4	1	0	1

I have already suggested to you that the variation of the anterior space and the anteroposterior relationship at birth may be factors related to occlusion. Before predicting the type of occlusion that the newborn may develop, one must consider many factors. Let us see what information can be gained by studying the width of the gum pads at birth. A norm must first be established for this dimension in order to make a comparison. In 1938, I published such informa-

Fig. 4.—A few casts of Bernard's series, illustrating changes in morphology and poor occlusion. (Numbers represent age in years.)

tion, which showed that the mean value for the maxillary width (W_U) for thirty-nine males was 26.3 ± 1.74 standard deviation and for forty-five females was 25.9 ± 1.37 standard deviation. For the mandibular width (W_L), the mean was 22.9 ± 1.39 standard deviation for forty-one males and 22.9 ± 1.59 standard deviation for forty-five females.

When comparing the individual widths of the jaws at birth of my present study with this norm, twenty-two children in a group of thirty-eight have widths outside the range of the norm. Of these twenty-two children, seven (31 per cent) developed good occlusion, while fifteen (68 per cent) developed poor occlusion. In other words, this is another factor which may be related to subsequent poor occlusion.

Is there a pattern of change of widths of the dental arches of an individual from birth onward? Does the pattern bear any relationship to subsequent occlusion? In order to approach the answer to these questions, measurements of each series of casts were made of thirty-eight children. Each series consists of six to twenty-five sets of casts, the average being one set of casts per year. What measurements could be traced throughout each individual series from birth onward? As stated previously, at birth there are many landmarks, but with time most of them become obliterated. However, the lateral sulcus, which also defines the interdental papilla, is clearly marked, and is located between the deciduous canine and the first deciduous molar. The crest of these papillae were the points from which the width of the maxillary and mandibular arches were measured. This was the only measurement which could be traced through each individual series with reasonable accuracy. Curves for each child were plotted, using the measurements (in millimeters) and age as coordinates. The maxillary arch is designated by W_U, and the mandibular arch by W_L. Each dot indicates the measurements of casts taken at that age.

Six children were selected, three with good occlusion and three with poor occlusion. Roger has a good occlusion (Fig. 5, *A, B, C*). His pattern of change (Fig. 6) is characteristic of a number of children with good occlusion. Note that there are periods of increase alternating with periods of no increase. The first increase in width (*A*) extends from birth to 0.034 year. This is followed by the shortest period of no increase or plateau (*B*), extending from 0.034 to 1.06 years. From 1.06 years to 1.92 years, there is a second increase (*C*) with a rate not as great as for the first increase. The second plateau extends from 1.92 years to 5.8 years (*D*). There is a third increase (*E*) from 5.8 years to 7.8 years, with a rate that is also less than the rate of the first increase. The third plateau (*F*) extends to 9.5 years. In other words, Roger's pattern of change is composed of three periods of increase alternating with three periods of no increase in width. The first increase has the greatest rate, while the second plateau has the longest span. The curves of both arches form a relatively parallel pattern to each other.

At birth, Roger's maxillary width (W_U) is 23.5 mm., and the mandibular width (W_L) is 18.5 mm., or a difference of 5 millimeters. Although Roger's width is below the norm, he has other factors which are more significant for a

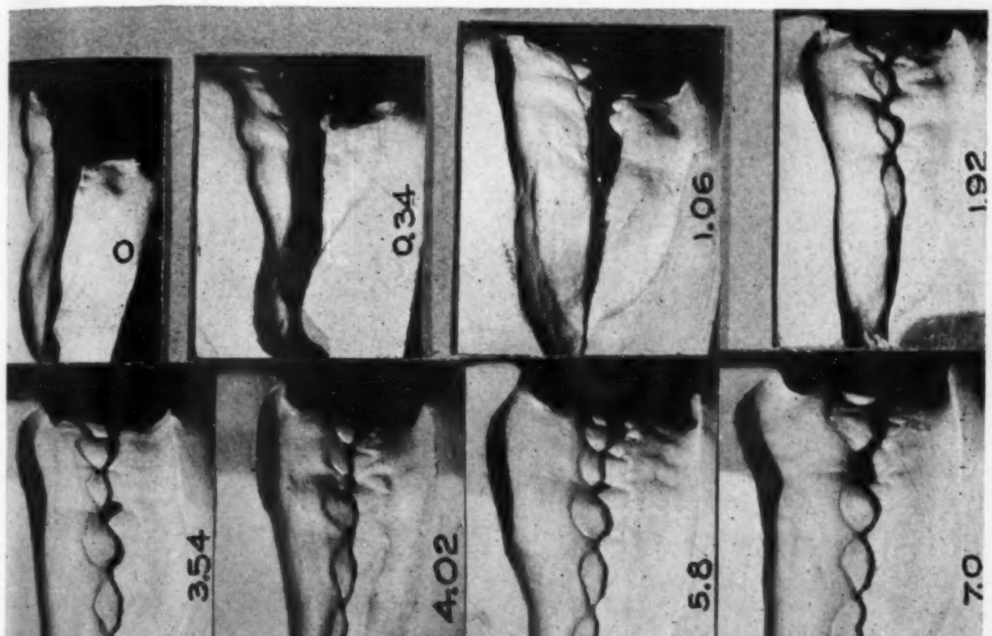

Fig. 5.—*A*, Right side view of Roger's series from birth to 9.5 years, showing good occlusion. (Numbers represent age in years.)

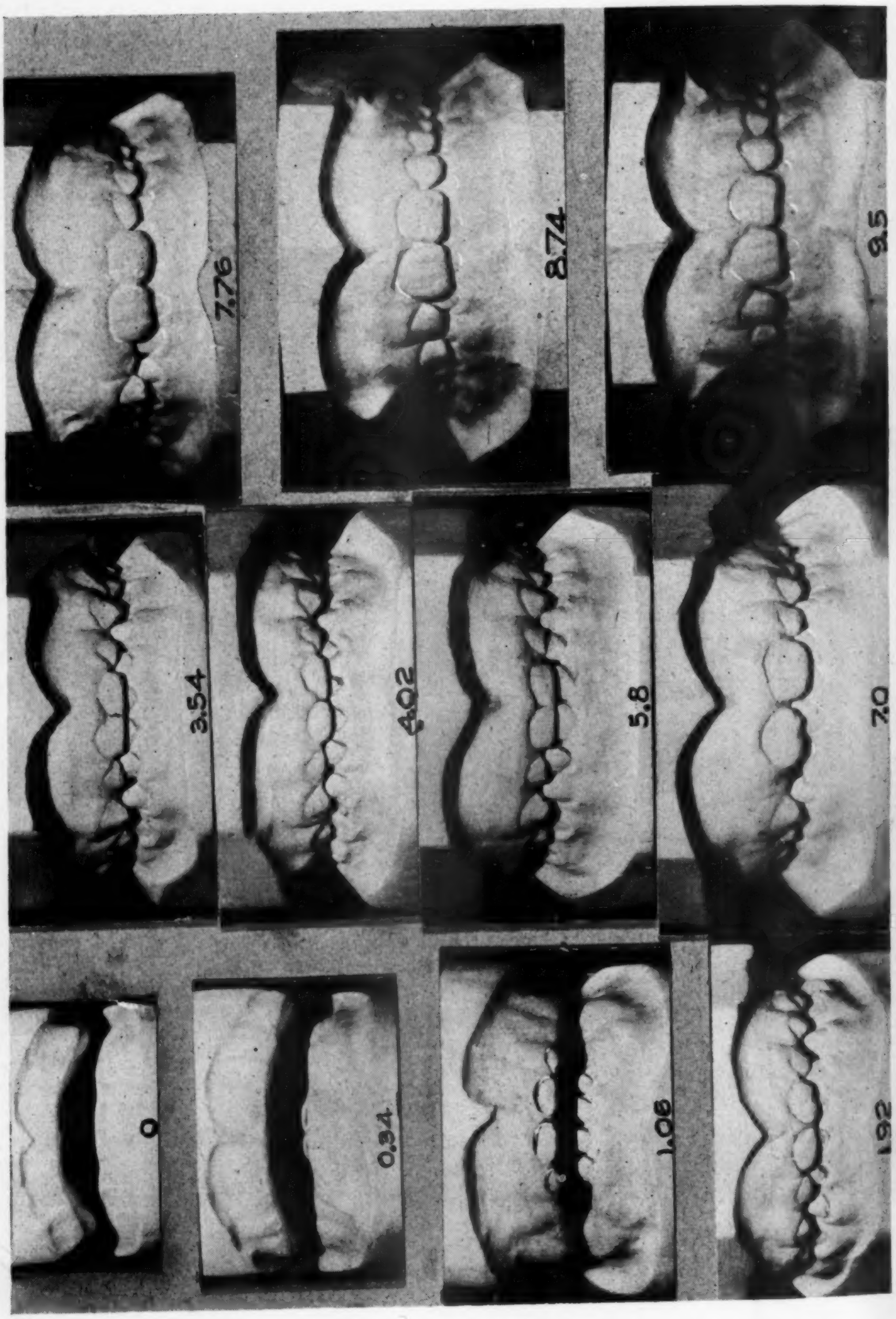

Fig. 5.—*B*. Front view of Roger's series. (Numbers represent age in years.)

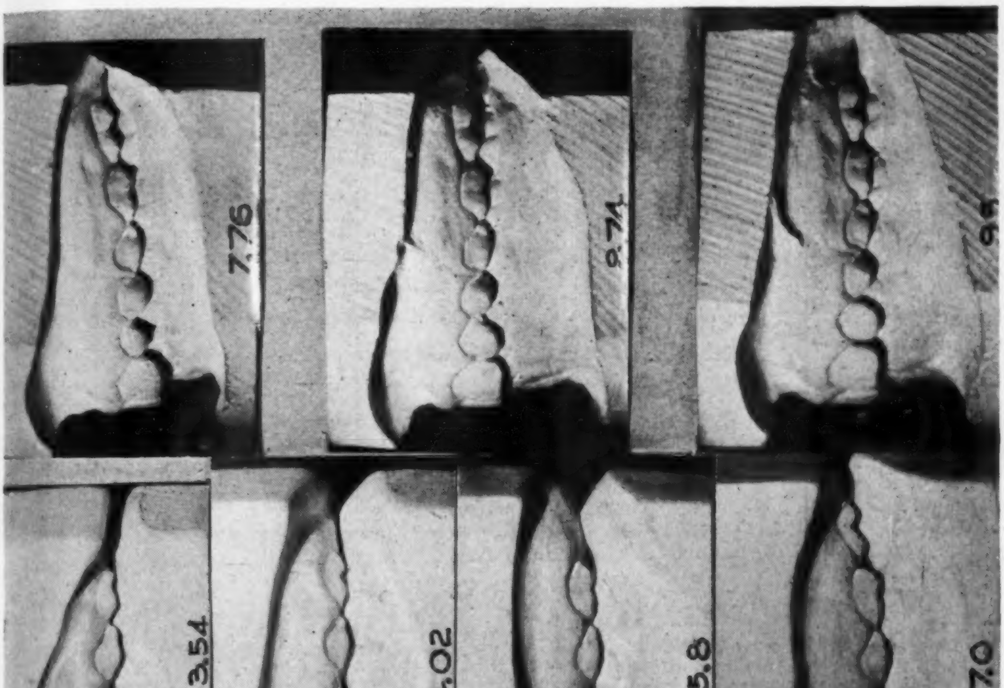

Fig. 5.—*C*, Left-side view of Roger's series. (Numbers represent age in years.)

good occlusion, that is, his symmetric pattern of change in width just explained. At 9.5 years the maxillary width is 35.3 mm., and the mandibular width is 28.8 mm., or a difference of 6.5 millimeters.

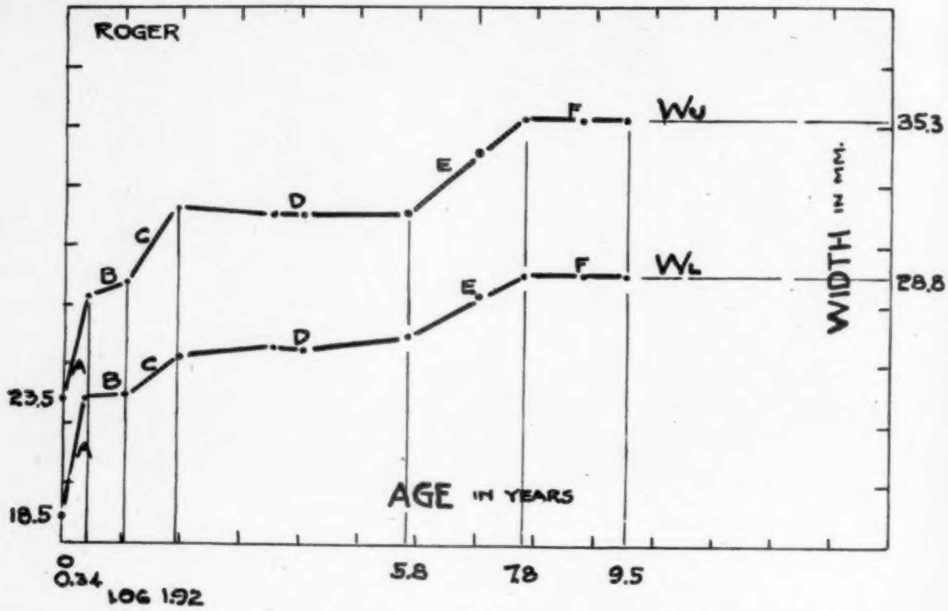

Fig. 6.—Roger has a good occlusion. Note the pattern of change is composed of three periods of increase alternating with three periods of no increase.

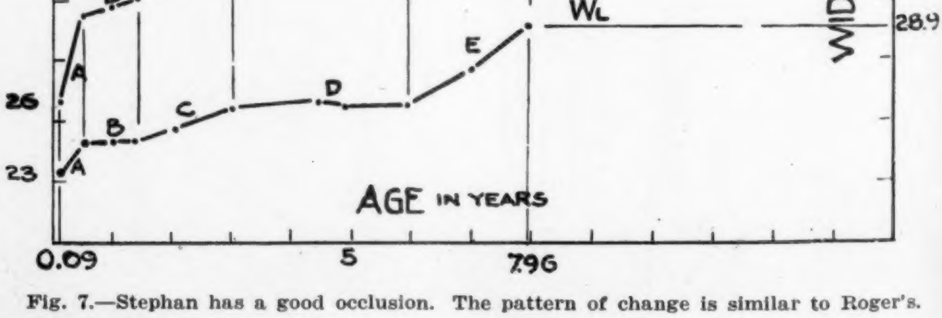

Fig. 7.—Stephan has a good occlusion. The pattern of change is similar to Roger's.

Stephan also has a good occlusion (Fig. 7). His curves form a pattern (*A, B, C, D, E*) similar to Roger's, although the onset, amount, and duration of increase, and the onset and duration of the plateau are individual. At 7.96 years the third plateau (*F*) has not appeared. At 0.09 year, Stephan's maxillary width is 26 mm. and the mandibular width is 23 mm., a difference of 3 milli-

meters. At 7.96 years, the maxillary width is 34.7 mm. and the mandibular width is 28.9 mm., giving a difference of 5.8 millimeters.

There are other variations of patterns among the children with good occlusion. Some exhibit a rhythmic pattern of three periods of increase alternated by three periods of slower rates of increase, rather than plateaus. Others show a partial expression of this rhythmic pattern, while some present a pattern of constant change.

Carol presents some variations of pattern (Fig. 8). The maxillary curve is similar to Roger's and Stephan's, but the second plateau has a slight upward slope (*D*). Her mandibular curve shows a decrease of 1.6 mm. in width between 1.22 years and 2.65 years. Does this suggest the onset of a defect of the arch? The decrease of dimension plus the constant varying of the dimensional differences between her two curves may foreshadow the development of poor occlusion. Although this child has good occlusion at present, her casts, taken at 9.9 years, suggest this change. Time will answer this question. However, the difference of dimensions between the arches at birth and 9.9 years approximate Roger's and Stephan's, and are within the range of measurements associated with good occlusion.

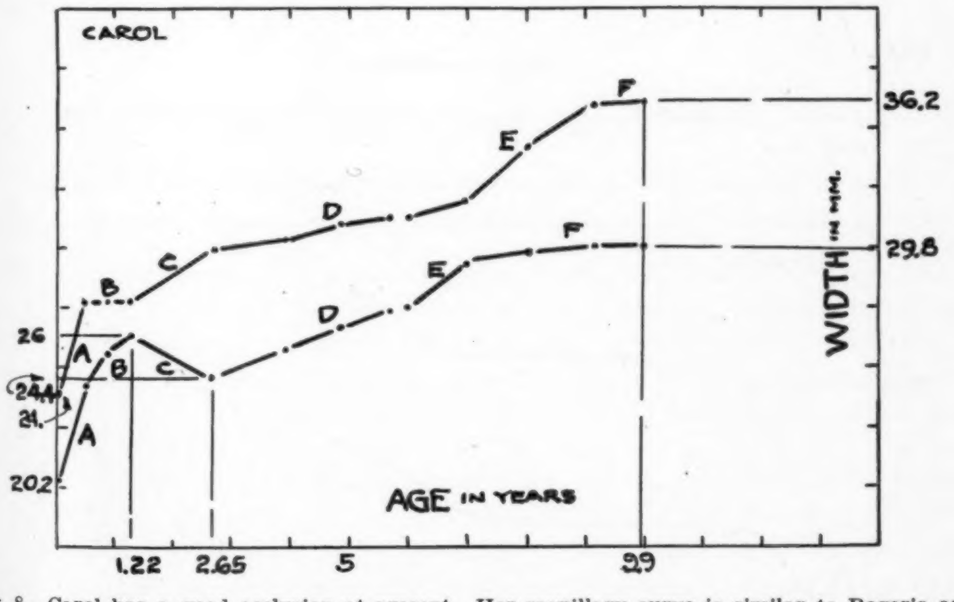

Fig. 8.—Carol has a good occlusion at present. Her maxillary curve is similar to Roger's and Stephan's. Note the decrease of dimension in the mandibular curve.

Figs. 9, 10, and 11 are examples of poor occlusion which are associated with a greater variation of differences of dimensions between the arches. I have 25 casts of Fred since his birth (Fig. 9), of which 12 were taken during his first two years. The diagnosis of poor occlusion was made clinically when he was 1.5 years of age. Are the irregularities of the curves occurring before this age a preclinical sign of future poor occlusion? Note the decrease in width at several points and also the varying rate of change in the curves, particularly in the maxilla. His difference in width between the arches seems to be of importance.

At 0.08 year, the maxillary and mandibular widths are 24 mm. and 20.2 mm., respectively, or a difference of 3.8 millimeters. Fred's widths at birth are below the norm. At 10.2 years the respective widths are 37.4 mm. and 28 mm., or a difference of 9.4 millimeters. This is the largest difference in dimensions found in this group, and may be another indication of poor occlusion.

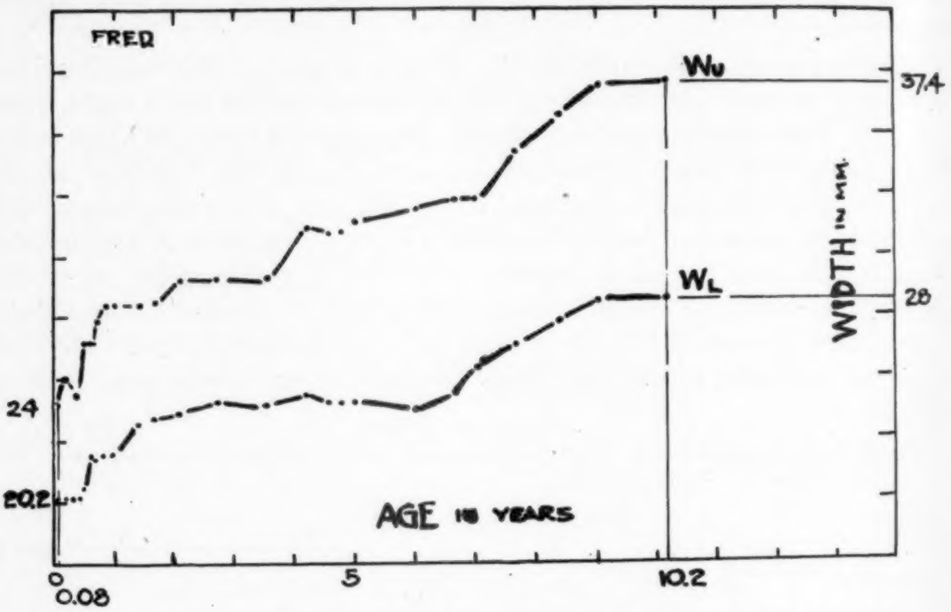

Fig. 9.—Fred has a poor occlusion. Note the irregularities and spread of curves.

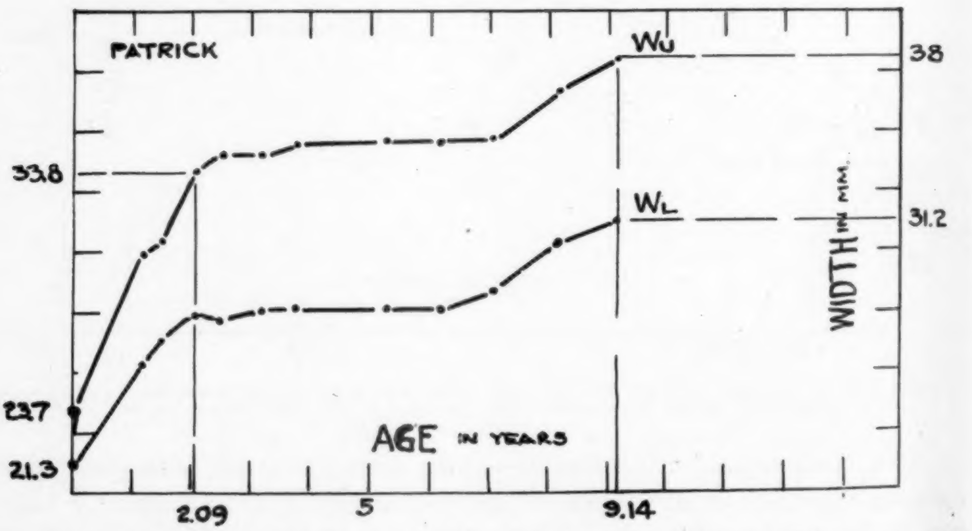

Fig. 10.—Patrick has a poor occlusion. Note the marked increase in the maxillary curve for the first two years.

Patrick is another example of poor occlusion (Fig. 10). His dimensional differences at birth are 2.4 mm., while at 9.14 years the difference is 6.8 millimeters. Of all the children in my group, he has the greatest increase in width in the maxilla during the first two years. At birth, the maxillary width is

23.7 mm., and at 2.09 years, it is 33.8 mm., or a difference of 10.1 millimeters. Did this large increase determine the development of his poor occlusion?

Bernard (Fig. 11), the brother of Patrick (Fig. 10), has a very poor occlusion. The varying dimensional differences between his maxillary and mandibular curves are of particular interest. At 0.17 year, there is a difference in dimension of 5.3 mm., and at 8.1 years, the curves have converged to a dimensional difference of 0.9 mm., which is different from the curves previously shown. Is this convergence of dimensions associated with the development of poor occlusion?

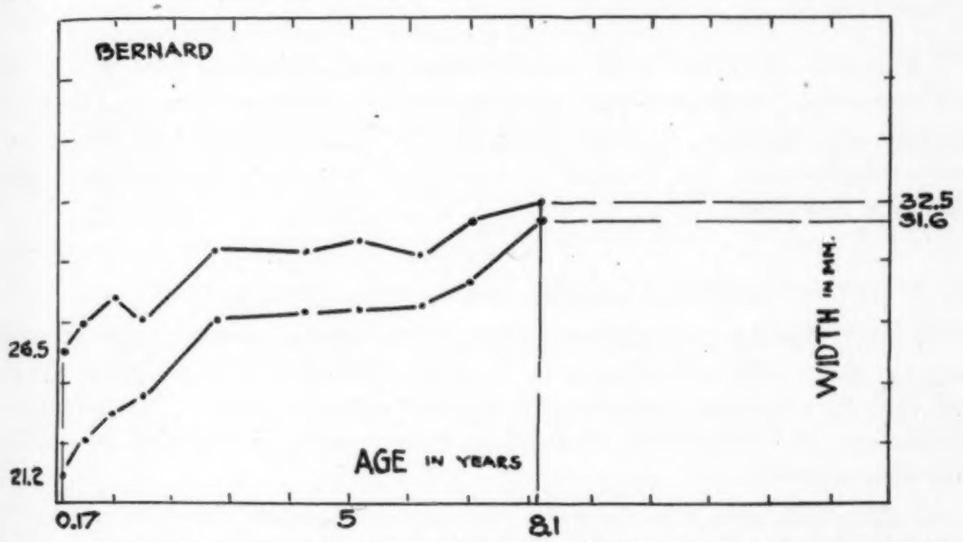

Fig. 11.—Bernard has a poor occlusion. Note the irregularities and convergence of curves.

In considering the group as a whole in regard to the influence on occlusion of decrease in width, the following findings are of interest. Among the sixteen children with good occlusion, six (37.5 per cent) show a decrease in width; of the twenty-two children with poor occlusion, thirteen (51 per cent) show a decrease in width. There is a suggestion here that the decrease in width is more likely to accompany poor occlusion.

The differences of dimensions between the dental arches also seem to have an influence on occlusion. (Table III contains part of the data that was used for studying the dimensional differences of the individuals of my series. The children in the table correspond to the curves shown.) At birth, the range of dimensional differences between the maxillary and mandibular widths for the entire group varies from 1.3 mm. to 5.8 millimeters. There are five children who at birth had a difference of widths of less than 3 mm.; four of them have poor occlusion to date. This suggests that the onset of poor occlusion occurred in the prenatal stage of development.

The difference of widths in the last casts ranges from 0.9 mm. to 9.4 millimeters. Five out of the six children with a difference of over 7 mm. have a poor occlusion. Of the four children with a dimensional difference of under 4 mm., three have poor occlusion, and the fourth child suggests a change toward poor occlusion.

TABLE III. ANALYSIS OF DIMENSIONAL DIFFERENCES OF WIDTHS IN RELATION TO OCCLUSION

		ROGER	STEPHAN	CAROL	FRED	PAT	BERNARD
Width at birth	W_U	23.5	26.0	24.0	24.0	23.7	26.5
	W_L	18.5	23.0	20.2	20.2	21.3	21.2
Difference at birth (W_U - W_L)		5	3	3.8	3.8	2.4	5.3
Width at last record	W_U	35.3	34.7	36.2	37.4	38.0	32.5
	W_L	28.8	28.9	29.8	28.0	31.2	31.6
Difference at last record (W_U - W_L)		6.5	5.8	6.4	9.4	6.8	0.9
Occlusion	Good	*	*	*			
	Poor				*	*	*

Moreover, occlusion is not static. Some good occlusions may become poor, and vice versa. I believe that there will be a greater increase in the number having poor occlusion, thereby increasing the significance of the association of poor occlusion with the decrease in width and difference of dimensions within the limits mentioned.

SUMMARY

1. At birth there is no occlusion between the gum pads.

2. (a) There is a suggestion that poor occlusion is more prevalent when anterior space falls into Classes B, C, or D. However, in some instances, good occlusion may develop regardless of anterior space at birth. (b) A change of morphology of the anterior space from symmetric to asymmetric is associated with poor occlusion.

3. The mandible was posterior to the maxilla at birth in 161 infants. The distance *A* ranged from 0 to 8 mm. with a mean value of 2.6 millimeters.

4. From the group of forty-eight children there were three (20 per cent) with good occlusion and twelve (80 per cent) with poor occlusion when the dimension *A* varied from 4 to 8 millimeters. This suggests that this range of dimension is more likely to be associated with poor occlusion.

5. Twenty-two children out of a group of thirty-eight have widths of the jaws at birth outside of the range of an established norm. Seven (31 per cent) developed into good occlusion, while fifteen (68 per cent) developed into poor occlusion. This suggests that poor occlusion may be foreshadowed at birth in many instances.

6. Smooth, rhythmic curves of the widths of the dental arches from birth onward are associated with good occlusion.

7. Irregular curves with lack of rhythm are associated with poor occlusion.

8. Among the sixteen children with good occlusion, only six (37.5 per cent) show a decrease in width, whereas among the twenty-two children with poor occlusion, thirteen (51 per cent) show a decrease in width. This suggests that decrease in width is more likely to be associated with poor occlusion.

9. (a) Four out of the five infants with a difference of less than 3 mm. between the widths of the maxillary and mandibular arches developed poor occlusion. (b) Five out of the six children with a difference of over 7 mm. between the widths of the dental arches, as seen by the last casts, have poor occlu-

sion. (c) Three out of four children with a difference under 4 mm. have poor occlusion. This suggests that dimensional differences within the limits mentioned are associated with poor occlusion.

I wish to thank Dr. Leo Winter, Dr. L. E. Holt, and Dr. W. E. Studdiford, in whose departments at Bellevue Hospital part of this study was made, Dr. Harry Bakwin for his counsel, and finally the parents and children who are cooperating in this study.

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667 MADISON AVENUE

THE USE OF THE TWIN WIRE MECHANISM IN THE TREATMENT OF CASES IN WHICH EXTRACTION IS INDICATED

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I HESITATED somewhat to read a paper on the use of the twin wire mechanism in the treatment where extraction is indicated for fear that some would think I had been carried away by the wave of extracting that is now sweeping some portions of the orthodontic profession. This is not true, however. Recently I examined the records of the last 500 patients on whom I had started orthotontic treatment. Out of this number I extracted in sixty-five cases or 13 per cent.

I have always believed in extracting in certain types of malocclusion, as, for instance, in the following:

1. Where the teeth are too large to be properly aligned on the bony base supporting them.
2. In bimaxillary protrusion.
3. Where there is a bimaxillary shift of the posterior teeth forward the full width of a premolar due to the early loss of the deciduous teeth.
4. In adult cases where extensive tooth movement is not practical or advisable.

The first case which I shall show you is of the latter type. It is a Class II, Division 1, of a woman 26 years of age. You will notice she has a tendency to an open-bite (Fig. 1, *A*). Her cuspids are elongated and tipped mesially. She already has some recession of the gums with a tendency to erosion along the gingival border.

Her molars and premolars all have large fillings in them. A full-mouth x-ray was made to determine the condition of these teeth. This is very important because if the first premolars were extracted and then the patient later should lose the second premolar or first molar, it would place the orthodontist in a very embarrassing position.

Bands were placed on all six of the anterior teeth (Fig. 1, *B*), the cuspid bands being placed first as they are more difficult to adjust. We do not know exactly how far the bands will have to be placed on the teeth to get an accurate fit.

After the cuspids have been placed in position, the lateral and central bands were made in line with them. This is an important procedure because if the lateral and central bands are made first and then the cuspid bands have to go higher on the tooth than had been thought necessary in the course of treatment, the cuspids would be elongated. This is the very thing we do not want to happen.

Read before the American Association of Orthodontists, Colorado Springs, Colo., Oct. 2, 1946.

A fixed lingual arch was placed on the maxillary arch. This is used to facilitate the seating of the molar bands, and also to stabilize the molars during treatment. In this case, the buccal tubes are soldered with the twin arch lying below the locks, so that when it is sprung up and locked into position, it will have a tendency to correct the open-bite (Fig. 1, *B*).

Since there is to be no expansion in the lower arch, a fixed lingual arch is used. Buccal tubes are also soldered to the molar bands. I prefer them to hooks because if it is necessary to use a twin arch later, the tubes are already in place.

After the appliances are adjusted, the patient is dismissed for two or three weeks to become accustomed to them. Then the use of intermaxillary elastics is begun. I choose an elastic at the beginning of treatment that does not exert more than two ounces of pressure.

Fig. 1, *C* shows the case after three months of treatment. You will notice that the anterior teeth have been moved lingually, the open-bite has been corrected, and, also, the crown of the cuspids has been moved into an upright position and about one-third of the space formerly occupied by the first premolar has been closed. Adults are very cooperative and make good patients because they are anxious to get their work finished as soon as possible.

Fig. 2, *A* shows the case two months later. You will notice the cuspids have been moved back to occupy about two-thirds of the first premolar space. They are now in their normal mesiodistal relation to the lower arch. Usually at this time a 0.0056 inch coil spring is placed on the twin arch between the lateral incisor and cuspid. This will slide the cuspid slightly farther back than normal. However, in this case coil springs were not found necessary. Later I will show a case treated by this method.

Since the six anterior teeth are back in their normal position and there is still space between the cuspids and premolars, elastics are now used from the hooks on the twin arch back to the buccal tube on the upper molar to shift the molar and premolars forward.

At this time, the upper lingual arch is removed because I find that usually one molar has to move forward farther than the corresponding molar on the other side and also that the lingual appliance seems to retard the mesial or distal movement of the molars.

You will notice that the axial angle of the cuspids has been corrected, but that they have been compressed too far lingually. To correct this condition, a knife-edge stone is used to cut the twin arch, just distally to the cuspids on each side. Usually within a month the spring on the twin wires will move the cuspids into their correct position.

In Fig. 2, *B* observe that the cuspid bands have been removed. This is done so that the hooks on the twin arch can be brought farther forward to get more traction from the elastics.

Nine months have now elapsed since the beginning of treatment. The case is almost complete except for a slight forward movement of the second premolar and molar on the right side.

This movement was soon accomplished and, twelve months from the day we started, all appliances were removed from both arches and the patient was given a Hawley retaining plate in the maxillary arch (Fig. 2, *C*). Instead of the clasp coming between the cuspid and second premolar, however, it was extended to the distal of the first molar. By placing the clasp on the molar, we prevent the tendency of the clasp to open a space between the cuspid and second premolar. While it is not quite as stable as the old method, I much prefer it.

No retention is necessary in the mandibular arch as it has only been used for anchorage. After the patient had worn the Hawley retaining plate for a month, she was instructed to leave it off in the daytime and wear it at night.

After three months, she was dismissed with the instructions that as long as the plate fit properly there was no need for her to come to the office. This is one of the great advantages in extracting in these older cases.

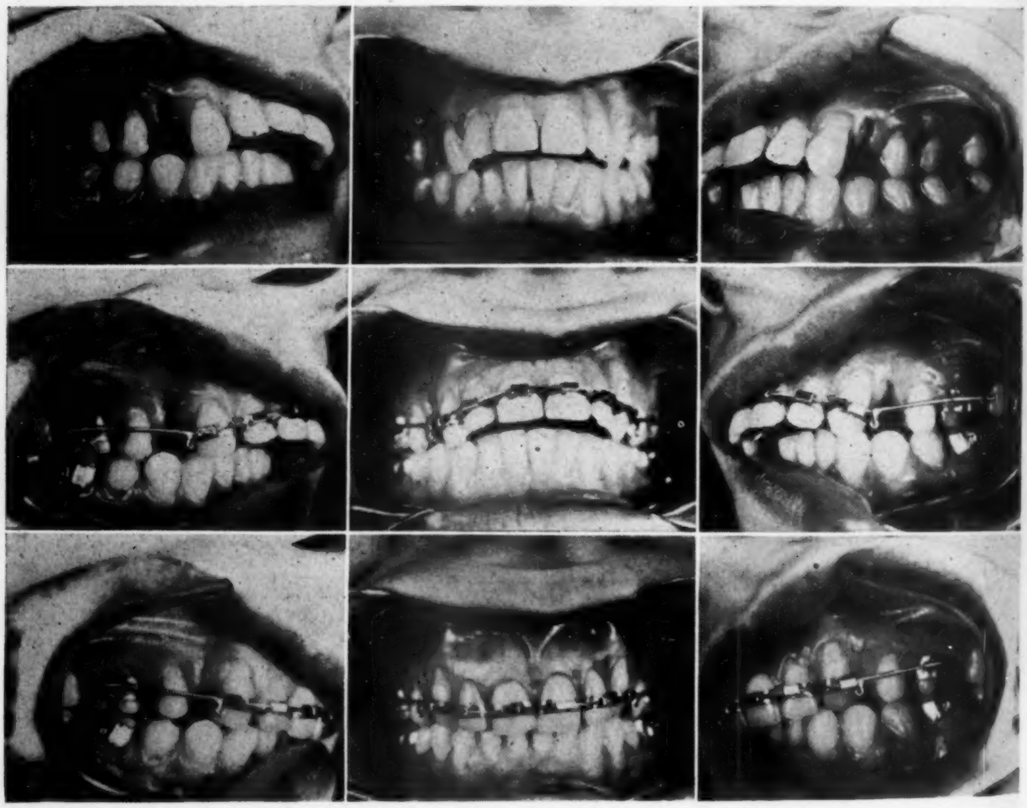


Fig. 1.

Fig. 3 shows the case five years later. The teeth are in a little better occlusion than when I gave her the Hawley plate.

Fig. 4 shows the profiles of the case before and after treatment. The remarkable thing about this girl was the slight deformity she had when her face was in repose. I think this was due to the fact that, as she said, she had always attempted to hold her lips together. Evidently this had caused an elongation of the upper lip.

Fig. 5 is a similar case showing the use of the coil spring between the lateral incisor and cuspid. The moving of the cuspids farther distally than necessary is an almost universal practice with me now. As previously mentioned, the spring is made of 0.0056 inch stainless steel wire. It is never compressed more than one thirty-second of an inch, which will exert a pressure of about three ounces. Fig. 5, *B* shows the cuspid moved back four months later.

The cuspid bands were then removed and the hooks on the twin arch brought farther forward. Fig. 5, *B* (center).

Four months later the spaces between the lateral incisors and cuspids had been closed as in Fig. 5, *B* (right).

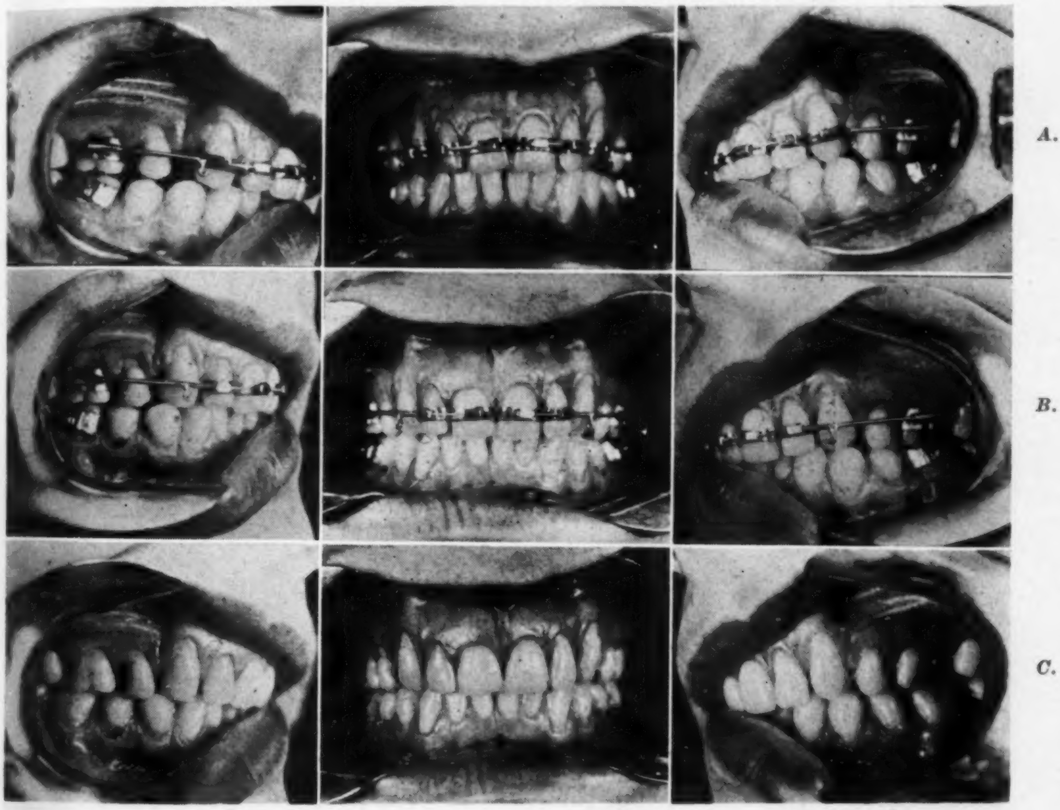


Fig. 2.

The next case is of a boy 16 years of age. He has what is apparently a Class II, Division 2 case. I believe, however, it was really more a shifting of the maxillary teeth forward than a distal moving of the mandibular (Fig. 6, *A*).

You will note that the left maxillary lateral incisor lies in the palate and that the space for it is almost completely closed (Fig. 6, *A*). He has an extremely deep overbite and a crowding of his lower anterior teeth.

He was suffering from an anemic condition at the time, which gradually grew worse during treatment but later was entirely corrected.

The parents were anxious to have the case finished as soon as possible as they wished to send him to school as soon as retention was begun. Therefore, it was decided to remove the maxillary first premolars.

Fig. 3.

Fig. 4.

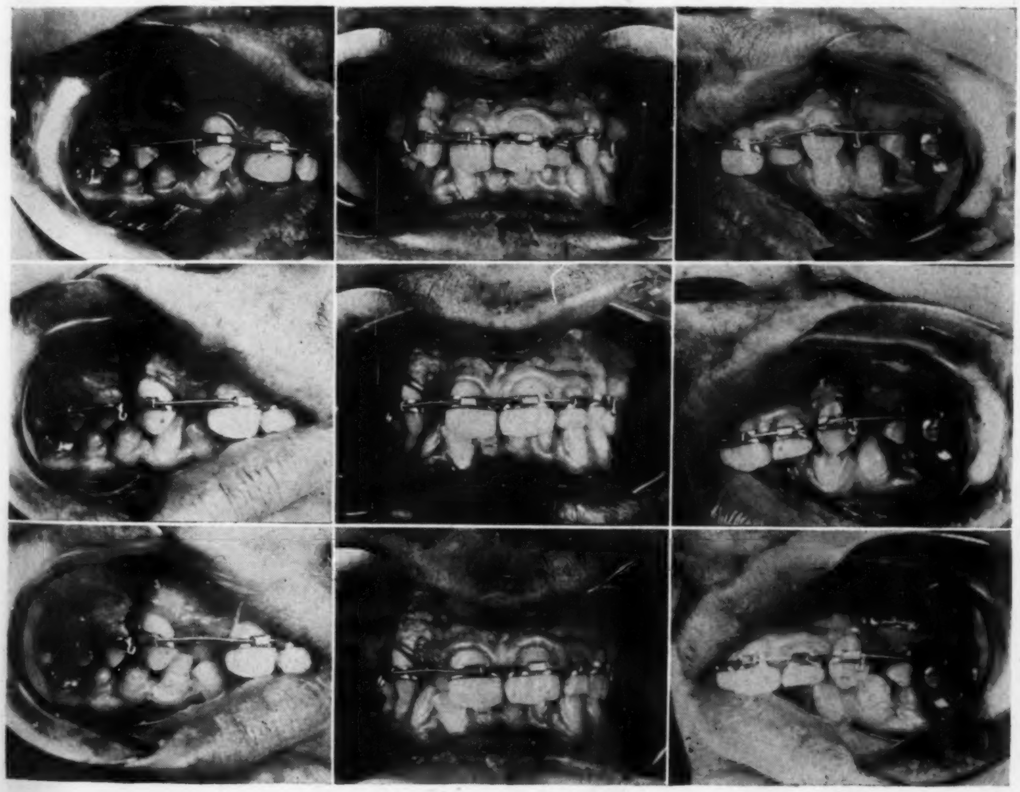
A.

B.

Fig. 5.

Fig. 6, *A* shows front and side views of the appliances. You will notice we have placed bands on the six anterior maxillary teeth. A coil spring has been placed between the right central incisor and cuspid to start moving the cuspid distally to make room for the right lateral incisor. Also, the left lateral incisor was so far lingual that it was not practical to seat the twin arch, so the cap was placed on the band before it was cemented. A wire ligature was passed through it and ligated to the twin arch to move it labially enough to seat the twin wires. The next pictures, Fig. 6, *B* were made five months later.

The right side view shows the amount of space that we have gained for the lateral incisor. The cuspid is almost back in its normal mesiodistal relation. In the meantime, the left lateral incisor has been brought out to its normal position.



A.

B.

C.

Fig. 6.

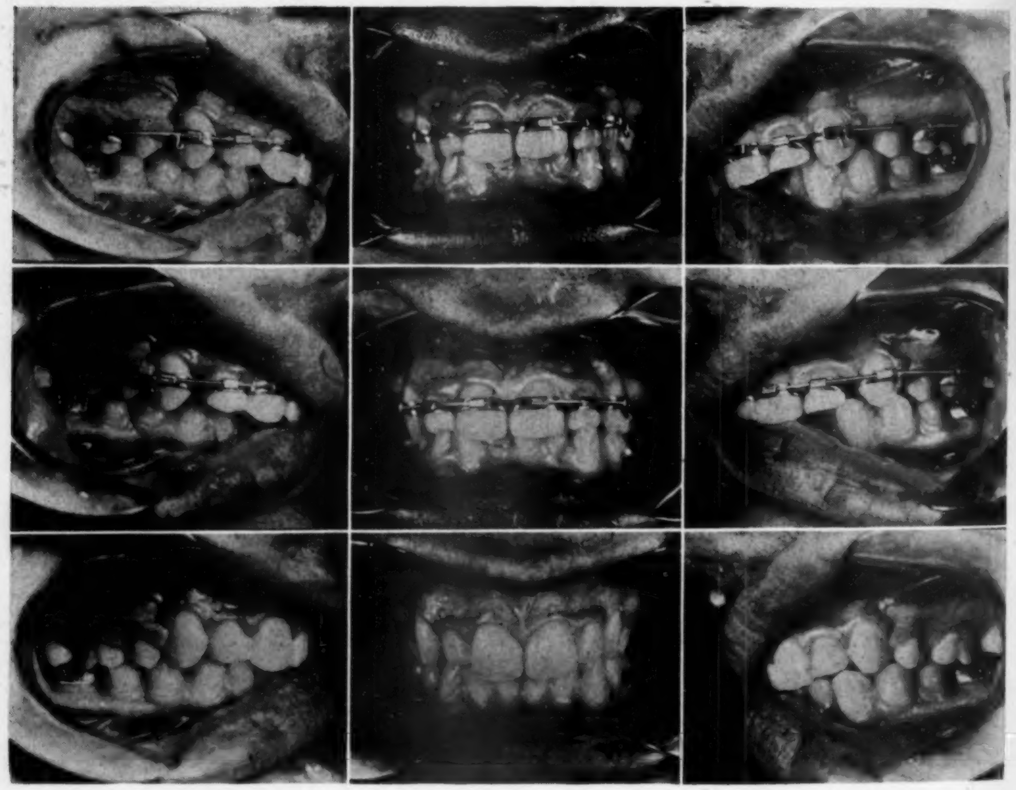
Fig. 6, *C* shows the case six weeks later. The space has been sufficiently opened to bring the right lateral incisor forward so a band has been placed on it and a ligature passed through the cap and ligated to the twin wires.

The cuspid has been moved distally to completely occupy the space of the first premolar, and the left cuspid, too, is almost in a normal position, due to the fact that the central incisors and the left lateral incisor have been shifted to the left to correct the median line.

The boy was not a good patient and did not wear his elastics faithfully, so did not do much to help move the four incisors lingually. At this time, a consultation was held with the parents and the importance of wearing the elastics was stressed most emphatically.

The next illustration, Fig. 7, *A* shows the case three months later. The right lateral incisor has been moved out into almost complete alignment and the results of constantly wearing the elastics have begun to show.

At this time, coil springs are again placed between the lateral incisors and cuspids and the latter are moved in contact with the second premolars (Fig. 7, *B*). The bands on the cuspids are then removed and the midsection of the twin arch shortened so that the hooks are lying opposite the middle of the cuspids. As previously mentioned, this is done to give a longer pull on the elastics.



A.

B.

C.

Fig. 7.

Fig. 7, *C* shows the case at the end of fourteen months' treatment. All appliances have been removed and he has been given a Hawley retainer to wear in the maxillary arch. Notice that the bite has been opened and that the anterior teeth have been slightly overworked.

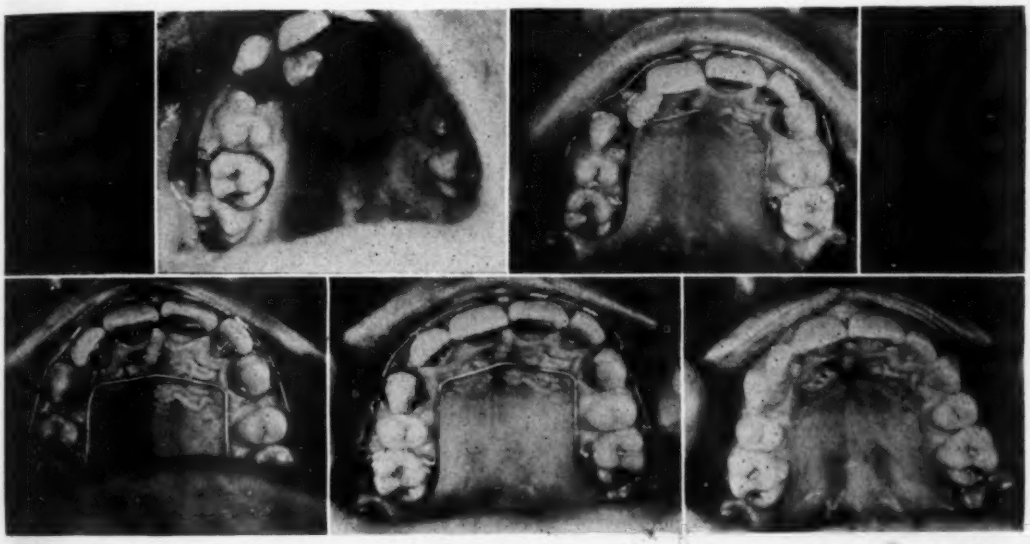
As the case progressed, it was found that a slight widening in the mandibular arch was necessary, so I used my staple arch to gain the expansion. At the

time the Hawley retainer was placed on the upper, the lower arch was remade and the molar bands recemented.

Fig. 8, *A* is a palatal view of this same case. The second picture illustrates the amount of space gained for the lateral in five months. Fig. 8, *B* (left) was made six weeks later with the twin arch locked to the lateral incisor.

Fig. 8, *B* (center) was made two months later with the cuspids jammed against the premolars, and the picture on the right was made at the time the Hawley plate was adjusted. The position of the lingual arch shows very clearly that the molars have not been shifted forward.

A.



B.

Fig. 8.

The third case is a girl 16 years of age. She had been under orthodontic treatment for two years before I saw her (Fig. 9, *A*). You will notice that her gums are in a bad condition and that the crowns of some of her teeth are badly etched, apparently due to poorly fitting bands and lack of oral hygiene. Also note that the pulp is dead in the left central incisor. However, this was not due to orthodontic treatment, but was caused by a blow several years before appliances were placed on the teeth. At a first glance one would assume that the case was a distoclusion, but a closer look at the photographs shows it is a neutroclusion with a labioversion of the anterior teeth. After some study, it was decided to remove the four first premolars, so appliances were placed as shown in Fig. 9, *B*.

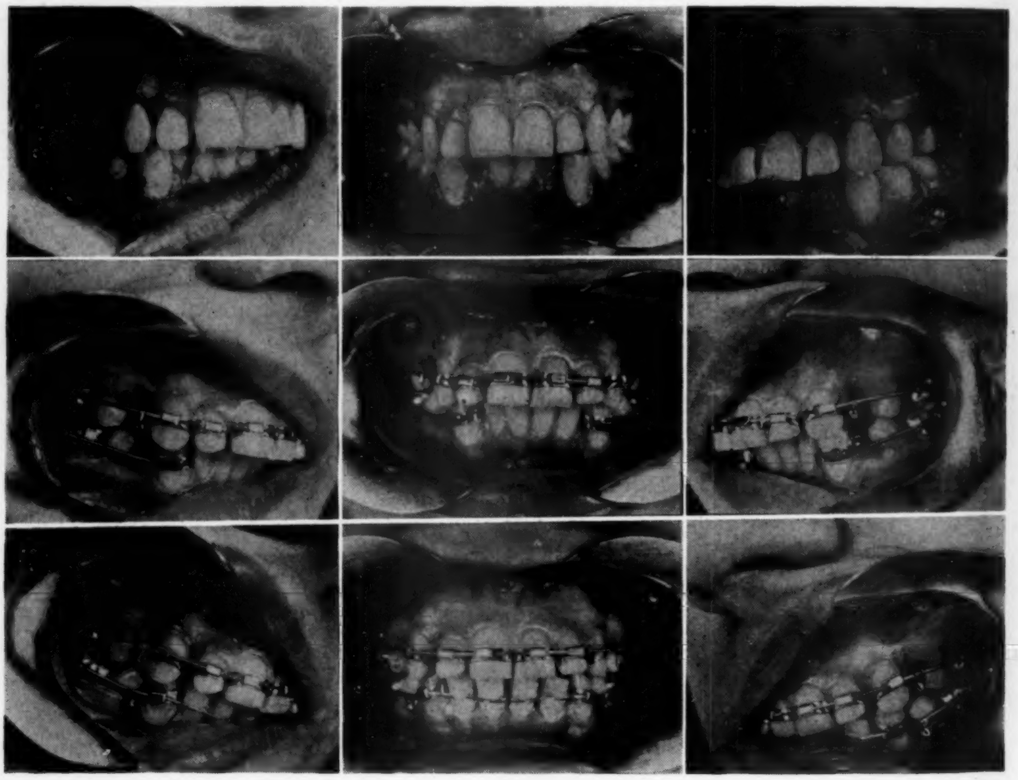
You will observe that I have banded the six anterior maxillary teeth and also the lower cuspids. Fixed lingual appliances were placed on both arches. The lower lingual arch is resting against the gingival border of the four lower incisors. The case was started with elastics extending from a hook on the lower cuspids to the tube on the lower molars.

The upper arch was allowed to remain passive until the lower cuspid had been moved distally against the second premolar. The lower molars remained

stationary because the lingual appliance was resting against the lingual of the four lower anterior teeth.

After the upper arch had been worn for a month, coil springs were placed between the lateral incisors and cuspids to move the latter distally. However, no elastics were used from upper to lower until the lower cuspids had been moved distally in contact with the second premolars, as shown in Fig. 9, *C*.

After the lower cuspids had been moved to their correct position, a twin arch was placed on the lower and ligated to the anterior teeth. However, if I were treating the case again, I would band the four anterior teeth instead of ligating them, as I have discovered that by pinching the lower anterior band on the labial and reversing it after soldering it is almost as easy to make a lower anterior band as it is to place a ligature on it.



A.

B.

C.

Fig. 9.

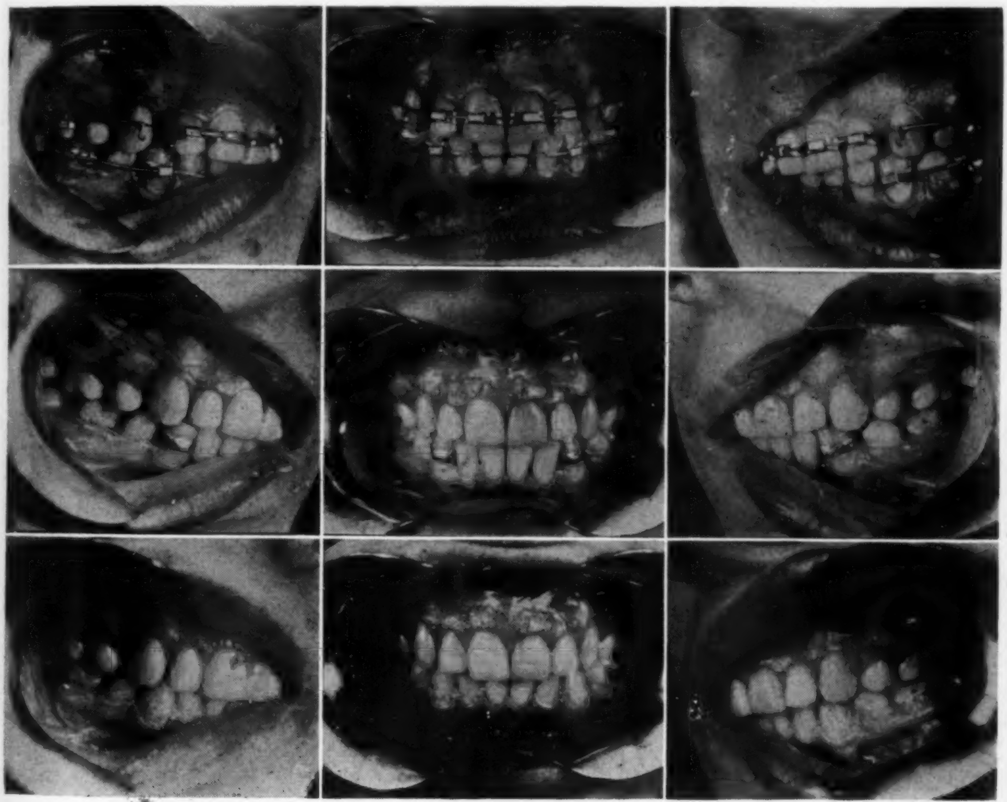
After the twin arch is adjusted, intermaxillary elastics are then used as though we were treating a mesioclusion case. To prevent the maxillary molars from moving forward, the end tube of the twin arch is bound in the buccal tube on the upper molar band. This is done by slightly compressing the buccal tube with a Young plier. By this method it is very easy to bind a tube in a tube.

Fig. 10, *A* was made ten months after treatment was begun. The mandibular teeth are in good alignment and the maxillary cuspids have been moved distally into contact with the second premolars. The bands have been removed on the former and intermaxillary rubbers are being worn from the maxillary

hooks to the lower molars as in the treatment of a distoclusion. The purpose of this is to move the central and lateral incisors lingually and close up the space between the lateral incisors and cuspids.

Fig. 10, *B* shows the case after thirteen months of treatment. All appliances have been removed. A Hawley retainer is being worn above with the clasp on the first molar instead of the premolars so as not to open the space between the cuspids and second premolars.

On the lower arch a lingual bar was soldered from cuspid to cuspid to prevent them from drifting forward again. Soon after I gave her a Hawley, she went away to school, so I did not see her for two years. When she returned, her teeth looked very good. (Fig. 10, *C*.)



A.

B.

C.

Fig. 10.

This was the first case I had ever treated by extracting four premolars. In treating this type of case now, I immediately band the six lower anterior teeth and treat it like a mesioclusion by having the patient wear intermaxillary rubbers from the hook on the lower twin arch to the buccal tube on the maxillary molar. As I have said, the end tube in the upper is bound in the buccal tube of the twin arch by pinching the latter.

However, in treating cases by this method, I often find that after the mandibular anterior segment has been brought distally so that the cuspids are in contact with the premolars, the second premolar appears depressed as in Fig.

12, *A*. It looks as though the second premolar has been depressed, but what has really taken place is the elongation of the mandibular anterior teeth and the mandibular molars. So a band with a spur is placed on the second premolar and ligated to the end tube of the twin arch. In a month or six weeks, the premolars are brought up in occlusion and, after being held for two months, the band can be removed and the tooth will remain in occlusion as in Fig. 12, *B*.

Fig. 11 shows the photographs of the girl at the beginning of treatment (left), one year later (center), and after three years had elapsed (right).

A.

B.

Fig. 11.

The fourth case is a girl 16 years of age. As you will notice in Fig. 13, *A*, she has a very decided tendency to an open-bite, especially in the lateral incisor and cuspid regions. The left lateral incisor is completely lingual.

There is such a complete lack of bony development that I regarded it as impractical to treat the case except by removing four first premolars, in spite of the fact that she had already lost her second mandibular molars. Bands were

placed on the six anterior teeth, both maxillary and mandibular, and, of course, on the first molars.

My staple arch was placed on the maxillary arch as both the first molars and second premolars were biting lingually and quite a bit of expansion was necessary in this region. A soldered lingual arch was placed on the lower to facilitate the seating of the molar bands in their correct position. As soon as the case was started, the lower lingual arch was removed.

You will notice from the side views (Fig. 13, *A*), the end tube on the lower left side is quite short, which gives a gentle upward pull on the lower left cuspid. I think it would have been wise if all the end tubes had been short like the lower left one, as the force exerted would have been lighter. However, they were crimped and most of the force was taken out of them.

A.

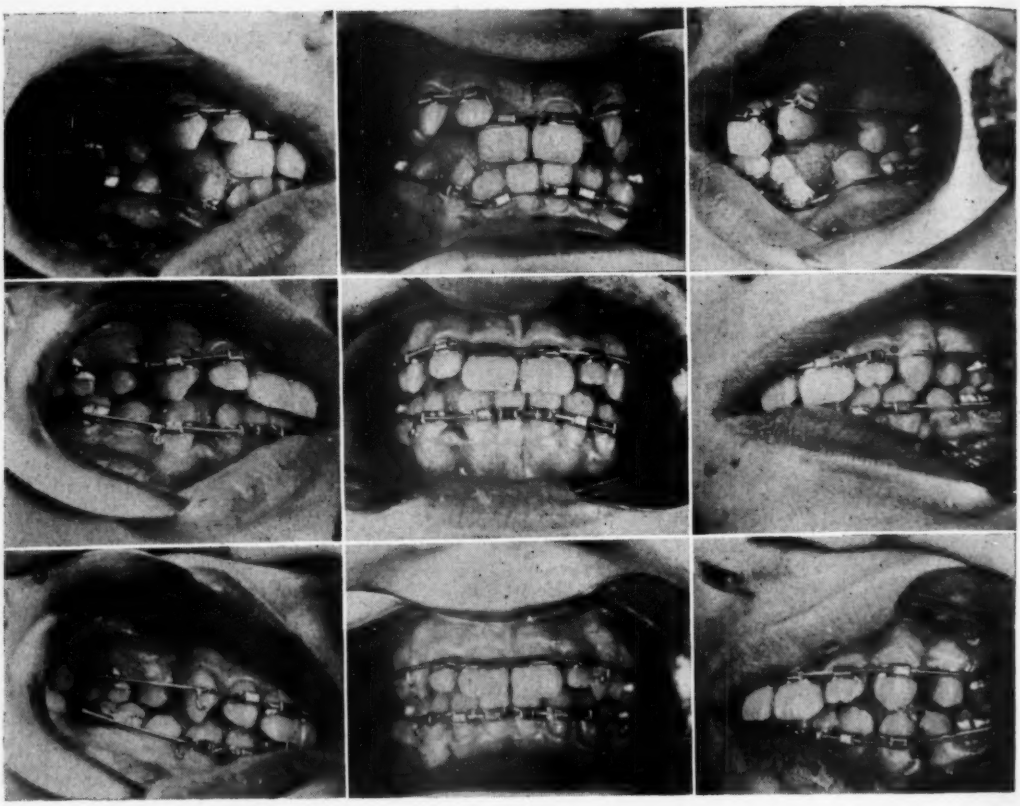
B.

Fig. 12.

I might mention at this time that the pulp had been destroyed in the upper right central incisor due to a large enamel filling placed on the labial surface. There was no response to the pulp tester on this tooth, so I told the young lady that the nerve was dead and had her consult her dentist. He said to let it go until it gave her trouble, which it did several months later. The tooth was opened up and the root canal thoroughly cleansed and filled.

Fig. 13, *B* shows the case eight months later. As you will notice, the mandibular arch was worked first. I moved the six lower anterior teeth lingually as though I were treating a mesioclusion, that is, rubber elastics were used from the hook on the lower arch to the buccal tube on the maxillary molar.

The end tubes on the upper appliance have been bound in the buccal tube in order to use the whole upper arch as an anchorage to move the six mandibular teeth lingually. As the case was worked, coil springs were placed on the



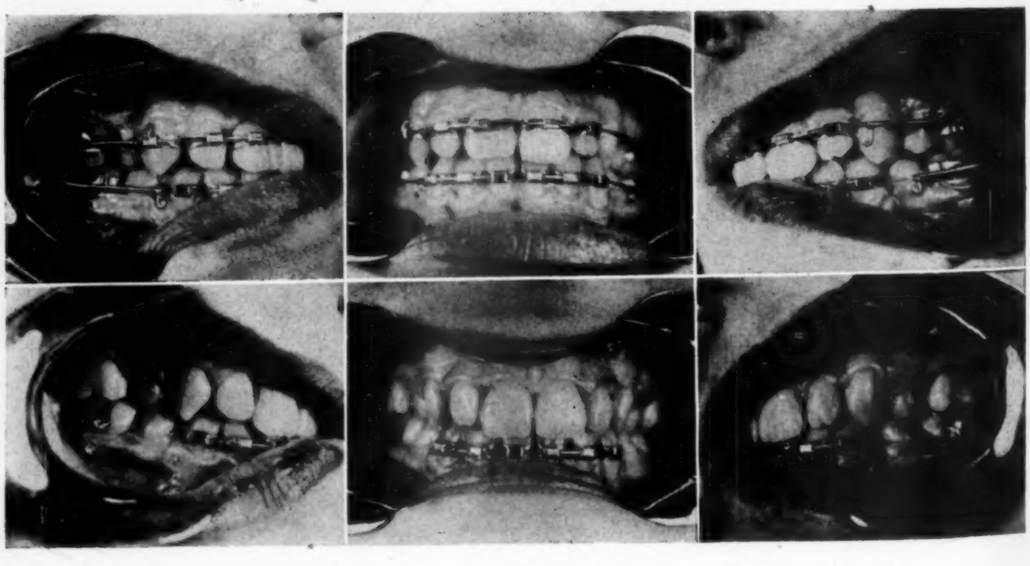
A.

B.

C.

Fig. 13.

A.



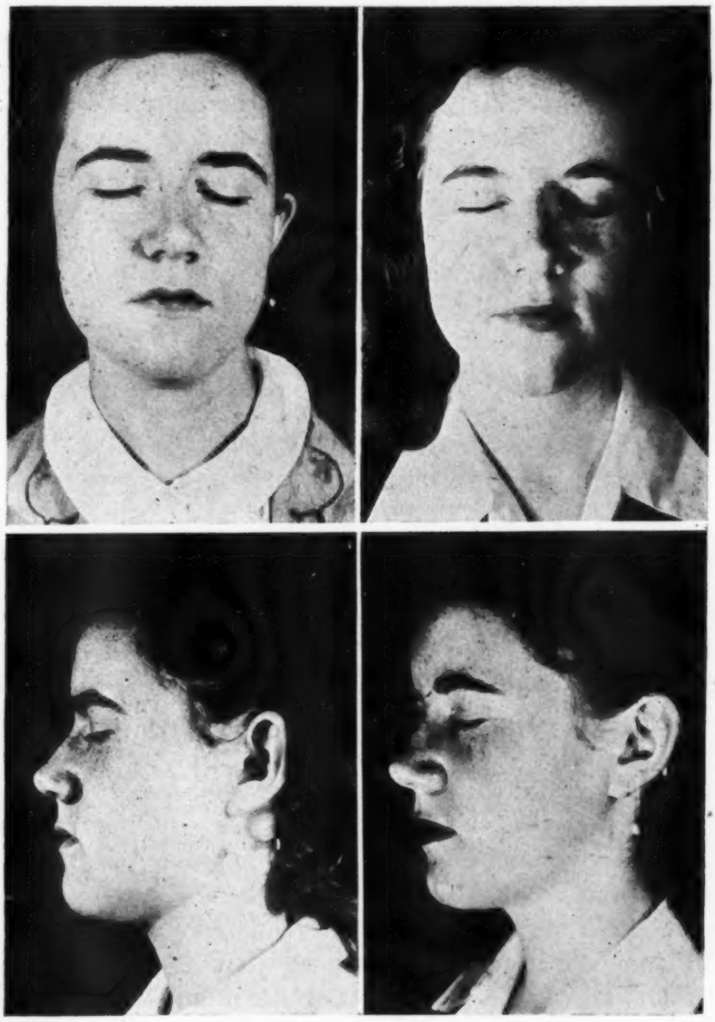
B.

Fig. 14.

twin arch between the lateral incisor and cuspid to assist in moving the cuspid back against the second premolar as clearly shown in the left illustration, Fig. 13, *B*.

Now, though the end tubes in the maxillary arch are bound in the buccal tubes for anchorage, we can also place coil springs on the twin arch between the lateral incisor and cuspid and begin the movement of the cuspid backward into the space formerly occupied by the first premolars.

A.



B.

Fig. 15.

You can also see that space for the left lateral incisor has been gained and that it has been moved forward toward its normal position (Fig. 13, *B*). This was done by placing a coil spring between the right central incisor and left cuspid. As the cuspid moved distally, space was gained for the lateral incisor, during which process a ligature was passed through the lock on the lateral

incisor and ligated to the twin arch. The lateral incisor was brought forward by this means until it had been moved far enough for the twin wire arch to be seated in the male attachment.

There has been quite a bit of development toward the occlusal plane in the lateral incisor and cuspid regions. This has been gained without the use of up and down elastics.

You will observe in the first series of illustrations (Fig. 13, *A*), the buccal tubes on the molar bands were soldered so that the twin arch, when placed in them, would lie near the incisal edge of the teeth of both the maxillary and mandibular arch. Of course, in the beginning of treatment the end tubes had to be bent so that the twin arch would lie almost passively in the male attachment. However, as the case progressed, new twin arches had less and less bend in the end tubes so that the lateral incisors and cuspids were gradually brought up into the line of occlusion with the downward pull of the twin wire arch. This gave us a much more gradual force than if we had used elastics.

Fig. 13, *C* shows the case in another six months. The case has been worked very gradually as I desired not only to bring the teeth into occlusion but also to have the alveolar process follow down with them.

At this stage of treatment, the cuspid bands in the maxillary arch have been removed. This is always done in these cases so that the hook on the twin arch can be placed farther forward to enable me to get more tension from the elastics, as shown in the side views, Fig. 13, C.

The right cuspid has rotated since the band was removed, as shown in the figure. Fig. 14, *A* shows that this cuspid has been rebanded and that I am now using elastics from the upper cuspid to the lower, not only to bring the cuspid into alignment, but to increase the overbite of the whole arch.

No doubt you have noticed that the left central incisor has been elongated. This condition was corrected by removing the band on this tooth and contouring it at both its incisal and gingival edges, which made it fit lower on the tooth. When the twin arch was replaced, it automatically shortened it. (Fig. 14, *B*.)

The right molar is in normal occlusion with the lower (Fig. 14, *A*). However, the left was more stubborn, so a cross-bite rubber is still being worn.

Fig. 14, *B* shows the case six months after all the upper appliance had been removed and a Hawley retaining plate placed in the upper arch.

Note that the lower molar bands have also been removed in the mandibular arch and that I am using a twin wire segment from cuspid to cuspid to hold the six mandibular teeth in their corrected position.

The left maxillary molar, which was rather stubborn to move buccally, has been brought out into its normal position. The second maxillary premolars still need to be moved slightly buccally. This is being done with 0.025 inch finger springs embedded in the acrylic plate.

Fig. 15 shows front and side views of the patient at the beginning of treatment and two years later.

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THE NEED FOR REFORM IN ACADEMIC ORTHODONTICS

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INTRODUCTION

A CHANGE has crossed the horizon, which has altered the direction of the stream of orthodontic progress. Old stagnant pools of conservative belief have been flooded with the storm waters of demonstrated truth, and the erstwhile cloudy and sluggish stream is beginning to run clear and swift once more. A new era has dawned in orthodontics.

The Angle classification of cases of dental malocclusion started the previous era, which began before the dawn of the present century. Research results obtained by Broadbent,[3] Brodie,[4-6] and others, and clinical demonstrations, notably by Tweed,[14, 15] have introduced the new era. It is important for those who practice as orthodontists or teach orthodontics to students to recognize clearly the changes which are now demanded in the theory and the practice of orthodontics. Because what is taught determines very largely what is practiced, the need has arisen for examining particularly the teaching of orthodontics. Inquiry has, therefore, been made into the teaching of the subject in one Australian university. Some particular aspects of this inquiry are domestic within this university, but the general features of it concern all schools in which orthodontics is taught, and it is to these aspects that reference is made in this article.

Teaching always depends largely on the prescribed textbooks. A survey of the books generally used in teaching orthodontics reveals that they possess some serious faults in common, but to different extents. Comments in the orthodontic part of this article are made, therefore, to reveal some of these faults, and suggestions are included for remedying some of them. In order to avoid unduly lengthy discussion, these comments are illustrated by reference to *A Textbook of Orthodontia,* by R. H. W. Strang.

The criticism, which is indicated indirectly through the comments in this article, has been suggested many times by students, who have complained that some aspects of the theory of orthodontics, as presented in various textbooks, are inconsistent with the basic subject, physics, and the theory of related subjects such as physiology and pathology. Hence, it is aimed to direct atten-

This article consists of two parts: Part I is written by an orthodontist—J. Wunderly, D.D.Sc., D.Sc. (Melb.), and Part II by a research physicist—J. F. Richardson, M.Sc. (Melb.), A. Inst.P.

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tion to these inconsistencies, and it is hoped that it will, at least, stimulate the writers of the textbooks on orthodontics to revise their contents.

For many years past, it has been clearly evident that students have regarded orthodontics as one of the most unpopular subjects in the dental course. That orthodontics, as a specialty, also lacks appeal among graduates can be judged partly from the fact that there are fewer than half a dozen recognized orthodontic specialists for Australia's population of over seven millions. Such lack of appeal to both graduates and undergraduates has the effect of reducing the amount of orthodontic treatment which the children receive, and, therefore, it constitutes a question of some importance in relation to national and individual health in Australia. An improvement in the teaching of the subject is the logical first step in the direction of creating enthusiasm for the practice of orthodontics in this and other countries.

All textbooks on orthodontics would be improved by the condensation of the text, the elimination of unnecessary repetition, the inclusion of definitions of orthodontic terms, and the avoidance of the use of inconsistent or inappropriate terms. Improvements such as these are conspicuous in the majority of medical textbooks which have been published in the past ten years or so, but many of their dental counterparts are obviously in need of being edited by experts.

A serious omission from the textbooks and teaching syllabuses of each dental school in Australia is the remote background of orthodontics, which is of particular importance in postgraduate teaching. The Australian undergraduate student is given adequate instruction in physics, anatomy, embryology, histology, dental anatomy, physiology, and pathology; but geology and anthropology are not included in the subjects for either undergraduate or postgraduate training.

In the absence of definitions or descriptions, the "underlying principles of orthodontics," which are referred to in textbooks on the subject, are unintelligible to students and teachers alike. As the principles on which orthodontic appliances, particularly the wire arches, should be designed and the properties which they should possess are not described in the textbooks, Part II of this article has been written to supply this need. Knowledge of these principles should result in improvements in the design of the appliances generally, and also in the methods of using them.

The suggestions for the improvement of the teaching of the subject which are submitted in this article are believed to be consistent with the conditions that surround dental teaching today, particularly in Australia. Doubtless, the conditions differ widely in various countries.

Part I. The Textbook on Orthodontics

INTRODUCTION

The introductory part of a textbook on orthodontics should contain a broad view of normal dental occlusion, dental deformities (malocclusion of the teeth), and the application of biologic and mechanical principles in the pre-

vention and correction of dental deformities. It should be comprehensive enough to provide an example to a student who might be asked to write an essay on the outline of orthodontics. The textbooks generally fail to give such a view. Strang* has thought it sufficient to refer in his introductory chapters principally to Angle's definition of orthodontics, his own extensive definition of normal occlusion of the teeth, and a detailed description of the normal relationships of human teeth. This lack in the text creates a huge initial difficulty for the undergraduate student.

Reference to the philosophy and the history of the subject should be included for graduate students. Parts of approved textbooks on geology, biology, and anthropology should be prescribed for reading by them.

Orthodontics, like pathology, is a subject that is largely concerned with the description of abnormal anatomic and physiologic conditions, and with the prevention or correction of them. Textbooks on orthodontics, nevertheless, include much which the student is taught in dental anatomy, histology and physiology. In practically all dental schools today, anatomy (including embryology and histology) and physiology are taught efficiently and comprehensively. Textbooks in orthodontics should not, therefore, contain matter which belongs appropriately to books on these subjects. They should, however, include detailed reference to those particular parts of these subjects which are of special importance in knowledge of the abnormal conditions that are exhibited in cases of dental malocclusion.

Human dental anatomy has been taught for a long time in the restricted sense of the term; that is, as a detailed description of the teeth themselves. It is logical to teach it as a detailed extension of the general anatomy of the head and neck. The scope should include the jaws, the teeth, and the soft tissues that are associated with them respectively. This does not mean that more burdens should be placed on the undergraduate student; it indicates, rather, that he should be given a broader and clearer picture of the dental environment, which determines largely the trend toward normal or abnormal dental occlusion. Knowledge of a reasonable amount of comparative dental anatomy is desirable. Similarly, when the student is being taught the changes that occur in the tissues during the movement of teeth by mechanical means, he should not be required to cover the ground which had been included in the teaching of histology.

The teaching of orthodontics should be limited to the abnormal conditions which constitute dental malocclusion and the principles and means of preventing or correcting them. The teaching of the corresponding normal conditions should be included in the instruction in other subjects, only revision and correlation being reserved for the instruction in orthodontics.

The need for the orderly and logical classification of the printed text is important in all teaching, and the conspicuous lack of it in textbooks on orthodontics in general, proves a great handicap to teachers and students alike.

*Chapter I, "The Basic Principles of Orthodontia"; Chapter II, "Normal Occlusion of the Teeth."

NORMAL DENTAL OCCLUSION

In general, circumstances do not permit the teaching of the background of the orthodontic picture to undergraduates. The undergraduate student, however, should learn the orthodontic foreground in relation to dental normalcy, before studying dental abnormality.

(a) The Anatomy of Normal Dental Occlusion.—The majority of the writers of the textbooks on orthodontics have concentrated their gaze on the trees to the exclusion of the forest scene. In other words, they have directed too much attention to the teeth, and too little to the head as a whole, or even to the whole jaw and its associated parts. Normal dental occlusion, which connotes more than occlusion of the teeth, is usually taught from the wrong end.

The student should first be taught the anatomy of the human head, the main types of human head, and the chief variations in size in each type. He should then learn the approximate proportion of each type, that is found in civilized or uncivilized people, in various races, and in the two sexes. This particular relationship was never more important than at present, owing to the inevitable and extensive intermingling of the peoples of the world, which has started as the result of World War II. The next logical step in his teaching is the relationship in size, shape, and position between the head, as a whole, and the jaw, as a whole, followed by that between the whole jaw and the alveolar process, the dental arch, and, lastly, the teeth. Knowledge of these relationships would prevent the mistaken aim to obtain an orthodontic result, that would be appropriate for an uncivilized individual, but rather unattractive at the meal table in a modern home of civilized persons. It would also reveal that what is normal in one race is not necessarily normal in another.

Strang* and others fail to give this broad view of dental normality, which is an essential part of orthodontic knowledge.

"Axial inclination of the teeth" is a phrase that is found frequently throughout the textbooks in descriptions of normal occlusion of the teeth. It is, however, more or less meaningless to a student, in the absence of a standard of comparison, such as a plane of orientation, that is suitable for clinical use. A standard orthodontic plane of orientation is needed for clinical purposes.

Embryology and histology are included in the subject of anatomy in the Melbourne dental course.

Knowledge of the normal growth of the jaws from birth onward is of paramount importance to all students of orthodontics. They should, therefore, learn the work and the results achieved by Broadbent,[3] Brodie,[4, 5, 6] and others.

(b) The Physiology of Normal Dental Occlusion.—The physiological aspects of normal dental occlusion that are important in orthodontics are related to diet, digestion, metabolism, exercise, rest, posture, etc., and also to various functions and psychological conditions. The Melbourne student will have gained some knowledge of these aspects during his study of physiology.

*Chapter II, "Normal Occlusion of the Teeth."

Strang would have improved his book if he had united three chapters (Chapter III, "The Physiology of Normal Occlusion of the Teeth and of the Organ of Mastication," Chapter IV, "The Forces Associated With Normal Occlusion of the Teeth," and Chapter V, "The Natural Mechanics of the Human Denture") into one, by condensation and clarification. "The Physiology of Normal Dental Occlusion" is preferable as a title compared with those chosen by him. Terms such as "the organ of mastication," "the human denture," and "the human mill" confuse the student because authors have not defined them. They are used sometimes synonymously, and sometimes asynonymously. "Forces," when used in reference to a practical subject, such as orthodontics, should be regarded as having a specific meaning signifying physical force, whether the power be derived from biologic or mechanical sources. The title of Strang's Chapter IV would be improved for teaching purposes by the substitution of "factors" for "forces." The physiologic view of normal dental occlusion that is given by Strang and other writers is too obscure and restricted to satisfy the demands of modern teaching.

DENTAL MALOCCLUSION

The terms "dental deformities" and "dental malocclusion" have a much wider application than the restrictive term "malocclusion of the teeth." Having learned the general anatomy of the head, as a whole, and the detailed anatomy of the jaws, the teeth, and the associated soft tissues, in normalcy, the student should be taught the anatomical, the physiologic, and the pathologic conditions, with which are associated the observed deformities in the jaws and the dental arches. Reference in this article to dental deformity should be understood to denote abnormality in form, size, or relative position in the head.

Dental malocclusion is a pathologic condition, and, as a subject, it should be treated as such. In cases of dental malocclusion, deformity is observed in the facial profile, the jaws, the dental arches, or in individual teeth. The incidence of dental malocclusion in the local population should be ascertained for teaching purposes.

The Pathology of Dental Malocclusion.—

A. Signs and Symptoms
B. Causes
C. Prevention
D. Treatment

A. The Signs and Symptoms of Dental Malocclusion.—

1. The anatomic signs and symptoms
   (a) The primary anatomic symptoms in the jaw, as a whole
   (b) The secondary anatomic symptoms in the alveolar process and the dental arch
   (c) The classification of the anatomic symptoms
2. The physiologic symptoms
3. The pathologic symptoms

B. The Causes of Dental Malocclusion.—

1. Physiologic causes
2. Pathologic causes

C. The Prevention of Dental Malocclusion.—

D. The Treatment of Dental Malocclusion.—

1. Physiologic treatment
2. Mechanical treatment.

A. The Signs and Symptoms of Dental Malocclusion.—

1. *The anatomic signs and symptoms:* The most important anatomic symptoms are exhibited in the jaw, as a whole. When deformity exists in the body of the jaw, the resulting asymmetry is conspicuous, and, in extent, it is roughly proportional to the degree of the deformity. The symptoms of less importance are seen in the alveolar process and in the dental arch.

For convenience in teaching, and in order to facilitate an understanding of the causes of the anatomic signs and symptoms, it is considered advisable to divide them into two groups; namely, the primary and the secondary symptoms. The former are related to the deformity of the jaw, as a whole, while the latter are connected with the alveolar process, and the arch of teeth.

(a) The Primary Anatomic Signs and Symptoms in the Jaw, as a Whole:

In the facial profile: Asymmetry in the facial outline can be detected fairly readily by visual observation. An experienced observer can readily visualize the form and relative position of the jawbone from the outline of the face, especially in cases of gross asymmetry. The textbooks provide good descriptions and illustrations of facial outlines in either normal dental occlusion, or dental malocclusion. Strang* has illogically dissociated his chapter from those chapters which relate to the deformities generally.

In the mouth: Subsequent inspection inside the mouth reveals important evidence of deformity, if it be present. By digital and visual examination of the soft tissues over the bone of the jaws and of the dental arches, while the mouth is open or while the teeth are occluded, deformity of the jaw in size, form, or relative position in the head can be determined, within clinical limits.

(b) The Secondary Anatomic Signs and Symptoms in the Alveolar Process and the Arch of Teeth:

Theoretically, any deviation from normal occlusion of the teeth, no matter how small, is accompanied by deformity in the bone of the alveolar process and that of the body of the jaw. However, when the deformity in the arch of teeth is only slight, the corresponding deformity in the body of the jaw is so small that it is undetectable by ordinary clinical means. Therefore, for practical clinical purposes, the condition in the body of the jaw, in such cases, is ignored.

Visual examination of the arch of teeth, of roentgenograms, and of plaster models of the teeth reveals deformity in the arch, if it is present. The abnormality in the arch is a measure of the deformity in the alveolar process.

*Chapter X, "The Facial Lines in Malocclusion of the Teeth."

(c) The Classification of the Anatomic Signs and Symptoms:

Probably the greatest individual contribution to the progress of orthodontics is Angle's classification of cases of dental malocclusion, which, through generalization, introduced order out of chaotic particularization.

The distinctive feature of "Angle's classification of cases of malocclusion of the teeth" is that it is essentially a classification of conditions of the jaws, and not of the teeth. Strang* states that "attention has been directed to the fact that malocclusion is but a symptom of defective or impaired growth and development of the bones of the face, especially those that enter into the formation of and give support to the structures that comprise the organ of mastication." Actually, the particular conditions of the jaws, to which Angle's classification is applicable, are themselves symptoms. This fact consequently suggests that the conditions of the jaws should be regarded as primary symptoms, while the conditions known, collectively, as malocclusion of the teeth, should be recognized as secondary symptoms. This distinction, in turn, draws a line between the causes of the primary and those of the secondary symptoms.

The Angle classification is based fundamentally on the anteroposterior relationship of the jaws to the head, as a whole. It holds good only within clinical limits of determination. For practical purposes, Angle chose to regard the body of the upper jaw as being in a fixed anteroposterior position in the head, while, in some cases of dental malocclusion, the corresponding position of the mandible varies. Angle's classification, therefore, ultimately depends on the anteroposterior position of the mandible in the head, and, on this basis, he divided all cases of dental malocclusion into three classes.

In Chapter VI, Strang gives seven definitions of the three classes and their main variations. The following are the definitions of major importance:

Class I.—All cases of malocclusion in which the body of the mandible and its superimposed denture are in correct mesiodistal relationship with cranial anatomy. Of these two factors, the position of the body of the mandible is the more important item.

Class II.—Cases of malocclusion in which the body of the mandible and its superimposed denture are in distal relationship to cranial anatomy, and in which the maxillary incisors are in labioaxial inclination.

Class III.—Cases of malocclusion in which the body of the mandible and its superimposed dental arch are in mesial or anterior relationship to cranial anatomy.

Strang's definitions of the three classes and their variations are indeed long and verbose for an undergraduate to memorize verbatim. An introductory statement would obviate the inclusion and repetition of "of malocclusion," and "the body of"; "arch" could be used instead of "superimposed dental arch" or "superimposed denture," and "head" in place of "cranial anatomy." "Vertical" should not be used, unless a plane of clinical orientation be recognized. "Mesial" and "distal" are adjectives that are applicable only unilaterally to

*Chapter VI, "Malocclusion of the Teeth," and Chapter VII, "Case Analysis for Classification."

individual teeth, or to only one side of an arch. A bone, such as the mandible, or an arch of teeth, each of which extends to each side of the median sagittal plane, demands the use of "anteroposterior" to describe its position in a sagittal plane of the head.

The following shortened definitions are submitted as preferable for undergraduates:

Introductory Note: "Cases" in the definitions means "cases of malocclusion of the teeth"; "the mandible" means "the body of the mandible," and "A. P." means "anteroposterior." The general A. P. position of the lower arch corresponds to that of the body of the mandible.

Class I.—Cases in which the mandible is in its correct A. P. position in the head (primary symptom).

Class II, Division I.—Cases in which the mandible is posterior to its correct A. P. position (primary symptom), and the upper incisors are inclined labially (secondary symptom).

Subdivision.—The posterior relationship exists on only one side (secondary symptom).

Class III.—Cases in which the mandible is anterior to its correct A. P. position (primary symptom).

Subdivision.—The anterior relationship exists on only one side (secondary symptom).

A reason has already been stated for regarding these definitions as applicable, principally to the primary symptoms of dental malocclusion. Melbourne undergraduates display little difficulty in recognizing the conditions to which the divisions of Class II and the subdivisions of Class II and Class III apply, respectively. The conditions—secondary symptoms—which are grouped under Class I, however, and which comprise, roughly, 70 per cent of all cases of malocclusion, cause them perplexity. This suggests that, in the interests of undergraduates, the Class I primary symptom should be divided according to the various important secondary symptoms that are related to it. An attempt to do so is represented in Table I.

It will be seen that the suggested scheme of classification includes only three main classes, which are the ones that were originally submitted by the late Dr. E. H. Angle. Mr. C. R. Newbury, B.D.Sc., Melbourne, has pointed out that the creation of Class IV to include cases of "bimaxillary protrusion" was an illogical step. Even the term "bimaxillary protrusion"' is inappropriate for the anatomical condition to which it is applied.

Bimaxillary protrusion implies a relatively forward position of both jaws, which is a condition known to anthropologists as prognathism. Prognathism is an anatomical condition that is normal in uncivilized people, generally, in a few civilized races, and in a small proportion of individuals in every race. This is a normal condition that is outside the scope of practical orthodontics, which is concerned only with abnormal anatomical conditions in the facial part of the

TABLE I. A CLASSIFICATION OF DEFORMITIES OF THE JAWS AND THE DENTAL ARCHES*

PRIMARY SYMPTOMS			SECONDARY SYMPTOMS
BODY OF MANDIBLE		CLASS	DEFORMED ALVEOLAR PROCESSES AND DENTAL ARCHES
ANTEROPOSTERIOR POSITION (ANGLE'S CLASSIFICATION)	DEFORMITY		
Correct	Absent	*Class I*	
		Division 1	Lack width
		2	Lack length
		3	Buccal teeth drifted mesially
		4	Inharmony in median lines
		5	Overbite
		6	Open-bite
		X	Protrusion of upper and lower alveolar processes and arches (bialveolar protrusion)
Posterior	Present	*Class II*	
		Division 1	*Upper incisors inclined labially;* deformed bilaterally
		Subdivision	Deformed unilaterally
		Division 2	*Upper central incisors inclined lingually;* deformed bilaterally
		Subdivision	Deformed unilaterally
		Division X	Protrusion of upper and lower alveolar processes and arches (bialveolar protrusion)
Anterior	Present	*Class III*	Deformed bilaterally
		Subdivision	Deformed unilaterally
		Division X	Protrusion of upper and lower alveolar processes and arches (bialveolar protrusion)

*Suggested for clinical use, in place of the generally known "Classification of Cases of Malocclusion of the Teeth."

head. A better term for the condition of dental malocclusion that has been referred to as "bimaxillary protrusion," is "bialveolar protrusion," and this term is found superior for teaching purposes. As bialveolar protrusion is a secondary symptom which is found in association with any of the three classes of primary symptoms, it cannot logically be regarded as a separate class in the primary symptoms. For this reason, bialveolar protrusion is shown in the scheme of classification as a secondary symptom, which is designated Division X in each of the three main classes of primary symptoms.

2. *The physiologic symptoms:*

(a) Functional:

In some cases of dental malocclusion there is evident difficulty in the performance of various functions. For example, in open-bite and in gross Class II and Class III cases, difficulty is experienced in biting food, especially in the region of the incisors, or in swallowing it; breathing through the nose is difficult or almost impossible in some cases, and the pronunciation of various sounds is sometimes handicapped. In some instances, the saliva does not cover the whole of the oral mucosa or the teeth, and its condition varies from very "watery" to viscid in different cases.

(b) Psychological:

The behavior of children is sometimes influenced by the effects of dental malocclusion. Some patients, largely through persecution, acquire a feeling of inferiority compared with their fellows, and their behavior becomes characterized by aggressiveness or shyness.

3. *The pathologic symptoms:* In the majority of cases of dental malocclusion, various inflammatory conditions occur in the gingival tissues, with extensive hypertrophy or atrophy in some instances.

B. The Causes of Dental Malocclusion.—One of the greatest difficulties experienced by the Melbourne dental student lies in his effort to gain clear knowledge of the causes of dental malocclusion. After he reads Strang's chapters on the etiology,* he complains that he is unable to relate its teaching to that, which he had already received in physiology, anatomy, and pathology. An examination of these chapters reveals whether or not his complaint is justified.

Strang has divided the causes of malocclusion into three main groups which he has named "hereditary," "prenatal," and "postnatal," respectively. In a search for the ultimate causes of malocclusion, it is far more important to know whether the symptoms are related to physiology or pathology than whether they arose before, during, or after birth. The logical main division of the causes, therefore, is in accordance with their association with these related subjects. The question of when a cause was effective is of minor importance, but it should not be overlooked. It is a further assistance to the student if the causes are divided according to whether they produce the primary or the secondary symptoms.

Professor R. D. Wright, Department of Physiology, The University of Melbourne, has supplied, at short notice, a classification of the causes of dental malocclusion in a simple dichotomous form. He has requested that it should be regarded as a rough draft, merely to indicate the way in which he believes the problem should be approached. His classification is shown in Table II.

C. The Prevention of Dental Malocclusion.—

In the first paragraph of Strang's Chapter VIII, he has written "Consequently it must be frankly stated that very little is known about the primary cause or causes of retardation in growth and defective development of the structures comprising the area in which we are vitally concerned. It is for this reason that efforts directed toward the prevention of malocclusion are quite ineffectual." "Little is known about the causes of the primary symptoms of malocclusion or their prevention" is easier for the student to remember. When the student turns to Strang's Chapter XVIII, he is surprised, when he sees the subheading, "The Prevention of Malocclusion," followed by descriptions of methods that are suggested as likely to prove successful. Inconsistencies such as this confuse and discourage the student. Undoubtedly, much can be done to prevent some of the secondary symptoms of malocclusion, the causes of which are well known, and this is another reason in favor of distinguishing the primary from the secondary symptoms.

*Chapters VIII and IX, "The Etiology of Malocclusion."

TABLE II. CLASSIFICATION OF THE CAUSES OF DENTAL MALOCCLUSION

Whole jaw — Alveolar portion of jaw

- Cause of Malocclusion
  - Developmental
    - Local abnormality of development only
      - Hereditary
      - Nonhereditary
        - Cleft palate Synosteosis
        - Teeth
          - Too many
          - Too few
          - Deciduous prolonged retention
    - Local abnormality of development with other results as well
      - Endocrine abnormality
      - Nutritional abnormality
      - General disease processes
  - Nondevelopmental
    - Abnormal functions (e.g., mouth breathing)
    - Lost teeth with improper prosthesis
    - Trauma
    - Great or local disease of bone

The methods of preventing the preventable symptoms are suggested by the references already made to the symptoms, and the causes of dental malocclusion. The methods may be applied either physiologically or mechanically.

D. The Treatment of Dental Malocclusion.—

(a) Physiologic Treatment:

This kind of treatment, which is mainly preventive, is indicated by the references already made to the physiologic symptoms and causes of dental malocclusion. The services of the psychiatrist, the endocrinologist, the specialist in diet, and others, should be sought by the orthodontist for his patients, whenever necessary.

(b) Mechanical Treatment:

The Mechanical Principles of Tooth Movement: Under the subheading, "Mechanics of Individual Tooth Movements" (Strang, Chapter XVI), reference to the physical mechanical principles, that are applied in order to move teeth is conspicuous by its absence. If Strang had chosen a subheading, such as "Technique of Individual Tooth Movement," it might have been regarded as relevant to the text. As students often complain that Strang's mechanics is widely different from that which they were taught when studying physics, an attempt has been made to explain orthodontic mechanical technique in terms of physical principles.

Strang departs widely from a scientific approach to a consideration of the properties of an efficient orthodontic appliance when he writes "The inherent principles necessary to qualify a mechanism for use in the treatment of malocclusion of the teeth may be grouped under three main headings as follows: (1) Biological, (2) Mechanical, (3) Esthetic and Hygienic." A mechanism such as an orthodontic appliance does not possess inherent biologic principles, and it cannot apply them. He fails completely to refer to the physicomechanical properties of any type of appliance.

The efficiency of an orthodontic appliance should be considered under two main headings; namely, (1) the physical properties of the materials of which the appliance is made, and, (2) the design of the appliance, which largely determines its mechanical efficiency, and its suitability from the esthetic and hygienic points of view.

In Part II of this article, Mr. J. F. Richardson, M.Sc., Melbourne, A.Inst.P., describes the mechanical principles which are applied by means of orthodontic arches. A description of this kind has not been found in any textbook on orthodontics.

After reading Part II, it will be realized that the "edgewise" arch is used in an unscientific manner. On account of the nature of the deformities that are exhibited in cases of dental malocclusion, the tooth movements, the largest in number and extent, which have to be made, are those in a labiolingual or buccolingual direction, and it is in these directions in which an arch should provide the greatest flexibility. This arch, however, possesses this property in higher degree in an apico-occlusal direction. This is one way, in which the "ribbon"

arch is, in principle, superior to the edgewise type. In the latter arch the scientific advantage has been sacrificed for the sake of clinical convenience.

The Kinds of Tooth Movement: Under the subheading "The Three Orders of Tooth Movements," in Chapter XX, Strang states: "Dr. Angle divided the mass movements of teeth into three orders. In the *first* order he included labial, buccal, and lingual tooth movements, tooth rotations, depressions, and elongations; in the *second order* he placed the mesial and the distal tipping of teeth; and in the *third order* he grouped all root and crown shiftings that are accomplished by the use of the torque force. We will now consider the technic associated with the production of all of these various mass movements."

When the dental student reads this part of Chapter XX, he fails to find any reference to the kinds of movement, which he learned when studying the basic subject, physics. Physics teaches that movement of a body that results from the application of force to it, under specified conditions, may be of two kinds; namely, linear translation, which is movement in a straight line, and circular movement, which is also known as rotation. In the treatment of dental malocclusion, force is applied to teeth by means of mechanical appliances, in order to move them. Actually, the only movements, which can be effected in teeth are linear translation and circular movement. The physical principles that govern the application of force to a body apply equally to the forces exerted on the teeth.

A tooth undergoes linear translation when it is moved bodily in any direction. When a tooth is caused to turn about a longitudinal or a transverse axis, it performs a circular movement. Strang refers to circular movement about a transverse axis of a tooth as "tilting" or "tipping" the tooth, while he calls circular movement about a longitudinal axis "rotation" of the tooth. Strang uses "tip" and "tilt" as if they were synonymous. Custom may justify the use of the latter, but the former term is obviously inappropriate. He also uses "force" and "pressure" as having the same meaning. The longitudinal axis may be the median axis, or an axis in any other position through the tooth's section. The transverse axis may intersect a longitudinal axis at any point on its length, and it may be inclined to it or vertical to it.

The student has little difficulty in learning to subject a tooth to the circular movement, known as tilting. If he were reminded that the application of a couple is the most effective way to produce the circular movement about a longitudinal axis, known as rotation, he would be helped toward adapting the appliances available to him, to move the tooth in the desired way.

The linear translation, or bodily movement of a tooth, is more difficult to effect in some directions than circular movement. If the student be taught that circular movement must be avoided in a tooth which has to be subjected to linear translation, he will not be unduly troubled in using an appliance that is capable of producing this kind of movement.

The subject of the kinds of movement which can be effected in teeth would be more appropriately included in Chapter XXI, which relates to the movement of a single tooth, rather than in Chapter XXII, which describes the simultaneous

movement of a number of teeth or, in Strang's words, "the mass movement of teeth." In the latter chapter, reference could be made to the application of the principles to the movement of many teeth simultaneously.

It is suggested that the ways in which a tooth can be moved should be classified scientifically in accordance with the physical classification of the movements that result from the application of force to a body, rather than according to an empirical grouping that was chosen by an orthodontist who ignored the physical principles. Students who understand a scientific classification of this kind have little difficulty in learning how to apply force by a mechanical appliance in order to effect the various movements. Furthermore, it would help them to recognize the nature and degree of the malocclusion of individual teeth, or of groups of teeth.

The terms "depressing a tooth" and "elongating a tooth," the meanings of which are well known to experienced orthodontists, are particularly confusing to students. It is impossible to "elongate" a tooth by clinicomechanical means. "Inclined bends" in an arch wire is a term preferable to "mesial or distal tipping bends."

Admittedly, it is not easy to suggest appropriate terms for the student in place of those in common use, but the list shown in Table III will help the student to understand the meaning of the latter.

TABLE III

TERMS IN COMMON USE RELATING TO THE WAYS IN WHICH TEETH CAN BE MOVED	MEANING, EXPRESSED IN PHYSICOMECHANICAL TERMS
	Circular Movement
Tilting a tooth	Transcircular (about a transverse axis)
Rotation of a tooth	Longicircular (about a longitudinal axis)
Bodily movement of a tooth (in a labial, buccal, mesial, distal, or lingual direction)	Linear translation (in the various directions)
Depressing a tooth	Apicolinear translation
Elongating a tooth	Occlusolinear translation

Orthodontic Mechanisms: The textbooks on orthodontics generally contain clearly illustrated descriptions of the various mechanisms and the ways in which they are manipulated in practice. In the descriptions of the methods of using them for the treatment of different kinds of cases, however, there is a noticeable lack of orderly arrangement. It would be helpful for teaching purposes if these descriptions of method were grouped in accordance with the tabulated classification of deformities of the jaws and the dental arches, which is shown in Table I. If the first part of each description applied to the treatment of simple cases, and the second part to that of complicated cases, undergraduate and graduate students, respectively, would experience less difficulty than at present in learning the various methods and in tracing the descriptions of them. Briefly, the descriptions of the mechanical treatment of cases of dental malocclusion, which are scattered through the textbooks, should be integrated and arranged in a logical order.

SUMMARY

1. Inquiry has been made into the teaching of orthodontics in Australia, and also into the prescribed textbooks.

2. It has been found that a considerable part of the theory which is being taught is unscientific, and it is inconsistent with that of physics, physiology, and pathology.

3. Various improvements in the teaching of the theory of orthodontics have been submitted.

4. Ambiguous and otherwise inappropriate terms are generally used, which are not clearly defined. More suitable terms have been recommended.

5. Suggestions have been made for the clarification of the general view of normal dental occlusion, and of dental malocclusion, and also for the improvement of the standard classification of cases of dental malocclusion.

6. In Australian dental schools, the teaching of the immediate background of orthodontics is adequate, but there is absence of the subjects of the remote background from the syllabus.

7. The textbooks on orthodontics, in general, exhibit the obvious need for the condensation and the logical arrangement of the text.

In the writing of this article, I acknowledge gratefully valuable assistance from Professor A. B. P. Amies, Dean of the Faculty of Dental Science, Mr. J. F. Richardson, M Sc., A.Inst.P., Physicist, and Professor R. D. Wright, Department of Physiology, all of the University of Melbourne.

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Part II. The Mechanics of Orthodontic Wire Arches*

INTRODUCTION

This section of the paper contains a discussion of the physical principles applied in the mechanical correction of malocclusion.

It has, for many years, been the custom to use flexible metal wires for moving teeth relatively to each other and to the bones of the head, which contain them. The chief requirements of such wires are (1) resistance to corrosion; (2) resilience; and (3) flexibility. The first condition limits the range of metals to those corrosion-resistant metals which can be obtained as wires. These are usually gold alloys or stainless steel. The second and third conditions are discussed more fully below. Suffice it to say at present that the terms resilience and flexibility are not synonymous, and the distinction between them is important.

The general principle involved in using an orthodontic arch wire is that the energy stored in the wire when elastically deformed can be used to move teeth against the resistance of surrounding tissues. Orthodontic wires can be regarded as small beams, and the ordinary methods of engineering can be used to investigate their behavior under strain.

The Bending of a Straight Beam.—Consider first what happens when a straight beam is bent from its position of rest. Fig. 1 (*a*) shows a straight beam of any section. Fig. 1 (*b*) shows the same beam when bent under particular conditions of loading. It is evident that the upper part, $A'B'$, of the beam is now shorter than in the original beam and is in a state of compression, while the lower part, $A''B''$, is longer and is in a state of tension. The directions of the forces tending to restore the beam to its original position are indicated by arrows. The central portion shown by the dotted line is unchanged in length and no stresses appear in it. The surface at right angles to the plane of bending, which contains the dotted line, is termed the "neutral surface"; with the beam in its undeflected position, it is referred to as the "neutral plane."

Three cases of bending, which occur frequently, are shown in Fig. 2. In (*a*) we have the case of a cantilever, that is, a beam rigidly fixed at one end and loaded at the other. In (*b*) the beam rests on two supports equidistant from a central load. In (*c*) the ends of the beam are rigidly fixed and the load is again applied at the center. It is assumed throughout that the beams are uniform in section.

In all three cases the relation between deflection and load can be expressed for small deflections by the same type of formula; namely,

$$D = C\frac{Wl^3}{EI} \qquad . \quad . \quad . \quad . \quad . \quad . \quad . \qquad (1)$$

In this formula W is the load, l, the distance as marked, E, Young's modulus of elasticity, and D, the deflection of the beam at the point where the load is applied. C is a constant, the values of which depend only on the conditions of

*This work was financed by a grant from the National Health and Medical Research Council of Australia, and was carried out under the direction of Professor Arthur Amies and the supervision of Dr. H. K. Worner, now Professor of Metallurgy at the University of Melbourne.

TABLE I. VALUES OF I FOR BEAMS OF DIFFERENT SECTION

Section of beam	*I*
Circular, radius *a*	$\frac{1}{4} \pi a^4$
Rectangular, dimensions $b \times t$ (*t* in plane of bending)	$\frac{1}{12} bt^3$
Square, dimensions $t \times t$	$\frac{1}{12} t^4$

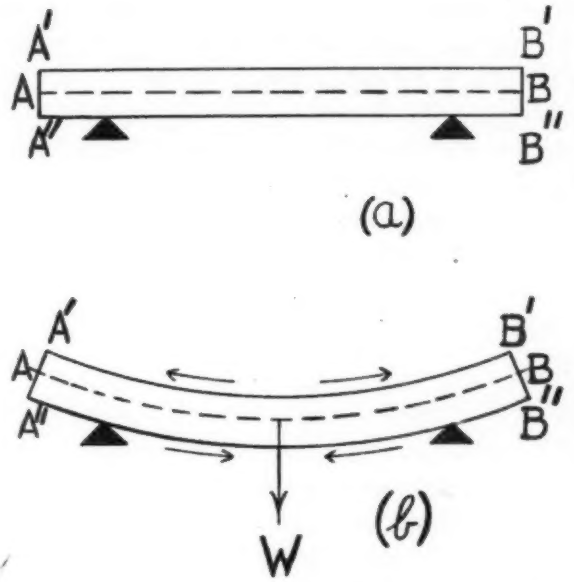

Fig. 1.—The bending of a straight beam by a central load.

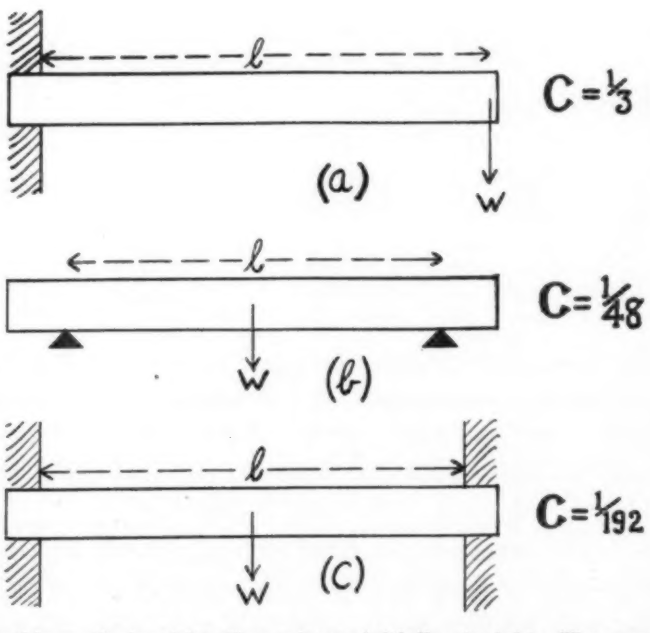

Fig. 2.—Three possible methods of bending a beam initially straight. The appropriate values of the constant, *C*, in equation (*1*) are marked in each case.

loading. (See Fig. 2.) I is the second moment of area of the section of the beam about the line formed by its intersection with the neutral plane. This quantity is often confused with the moment of inertia of the section, to which it is closely related. The value of I depends on the shape and size of the section. Formulas for I are set out in Table I.

Some general results can be stated from inspection of formula (1). Other things being equal, we see that: (a) for wires of circular section the deflection varies inversely as the fourth power of the diameter; (b) for wires of rectangular section, of dimensions $b \times t$, the deflection is inversely proportional both to b and to the cube of t when t is the dimension of the beam in the plane of bending; (c) for wires of square section and dimensions $t \times t$ the deflection is inversely proportional to the fourth power of t.

Consider the case of two beams, each supported as in Fig. 2 (b). If the beams are of the same material and the supports are the same distance apart in both cases, so that E and l are the same for both beams, we can compare the deflections of beams of different cross sections under different loads. Formula (1) then reduces to

$$D = k.W/I \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (1a)$$

k being a constant.

Table II shows the results of applying formula (1a) to single arch wires of different sections. Throughout this discussion the wires are assumed to be supported as in Fig. 2 (b) the distance between the supports being constant and the wires differing only in section. The arch wire of circular section and diameter 0.022 inch is arbitrarily taken as the standard for comparative purposes.

TABLE II. COMPARATIVE LOADS AND DEFLECTIONS FOR SINGLE ARCH WIRES

SECTION	DIMENSIONS (INCH)	DIMENSION IN PLANE OF BENDING (INCH)	LOAD REQUIRED TO PRODUCE EQUAL DEFLECTIONS OF CENTER (ARBITRARY UNIT)	CENTRAL DEFLECTION PRODUCED IN EACH WIRE BY THE SAME LOAD (ARBITRARY UNIT)
Circular	Radius: 0.011	0.022	1.00	1.00
Rectangular	(i) 0.028 × 0.022	0.022	2.17	0.46
	(ii) 0.022 × 0.028	0.028	3.50	0.29
Square	0.022 × 0.022	0.022	1.70	0.59

We can also investigate the bending properties of a number of separate wires acting together as a single unit. The practical example of such a combination of wires is the "multiple wire" arch. If there are n wires acting together, all of the same geometrical and physical properties, then formula (1a) becomes

$$D = k\frac{W}{nI} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

I is the second moment of area of any individual wire about its neutral plane. The conditions of bending are the same as before, and are necessarily the same for each wire in the unit.

Some results found by using formula (2) are shown in Table III.

TABLE III. COMPARATIVE LOADS AND DEFLECTIONS FOR MULTIPLE ARCH WIRES

SECTION	DIMENSION (DIAMETER) (INCH)	NUMBER OF WIRES (N)	LOAD REQUIRED TO PRODUCE EQUAL DEFLECTIONS AT CENTER (ARBITRARY UNIT)	CENTRAL DEFLECTION PRODUCED BY EQUAL LOADS (ARBITRARY UNIT)
Circular	0.022	1	1.00	1.00
Circular	0.015	4	0.86	1.16
Circular	0.012	2	0.18	5.68
Circular	0.012	6	0.53	1.88
Circular	0.006	16	0.089	11.3

The physical conditions assumed are the same for all wires and groups of wires, but such conditions only approximate those of orthodontic practice. Strictly speaking, the theory used can be applied only when the deflection of the wire is small and when the wire has not been permanently deformed. These conditions are never satisfied in practice. Nevertheless, useful estimates of the relative bending properties of arch wires can be obtained.

Formula (2) can be used to determine the number of wires in a multiple-wire arch necessary to give the same deflection as any given single wire under the same loading conditions. Formulas (1) and (2) could also be used for the approximate design of an arch wire having any desired flexibility.

Table IV shows the number of wires necessary in a multiple-wire arch to give the same "flexibility" as a single wire of circular section and diameter 0.022 inch. For the purpose of this work, flexibility is defined as the ratio of the deflection of the wire at the point of loading to the load causing it. It may also be regarded as a convenient name for the quantity $\frac{I}{EI}$. (The product EI is frequently termed the "flexural rigidity" of the wire.)

TABLE IV. NUMBER OF WIRES REQUIRED IN A MULTIPLE-WIRE ARCH FOR EQUAL FLEXIBILITY

SECTION	DIMENSIONS (DIAMETER) (INCH)	NUMBER OF WIRES REQUIRED FOR NEARLY EQUAL FLEXIBILITY	NUMBER OF WIRES USED IN PRACTICE
Circular	0.022	1	1
Circular	0.015	5	4
Circular	0.012	11	6
Circular	0.006	180	16

Flexibility is an important property of an orthodontic arch wire. Of two wires, the more flexible can move a tooth further for the same initial load provided always that the elastic limit of the wire is not exceeded, so that it tends to return to its undeflected (rest) position, moving the tooth with it at least part of the way.

Resilience of a Wire.—A knowledge of flexibility alone, however, is not sufficient to describe the behavior of an arch wire completely. A wire may be of good flexibility, yet may fail to return to its rest position after being bent through quite a small distance. This is an undesirable limitation. Another property, that of "resilience," is equally important. Of two wires of the same

flexibility, the more resilient can recover its rest position after being given a greater deflection than the other. Resilience is obviously a desirable property of an orthodontic arch wire.

The resilience of a wire is the maximum energy, recoverable in the form of useful physical work, which the wire can store when elastically deformed. It is helpful to review some fundamental ideas about elasticity to appreciate fully the significance of resilience.

The stress at any part of a body is defined as the force acting across each unit of area at that part of the body, the force being measured at right angles to the area. For example, if a force of ten units acts normally across an area of five square inches, the average stress across the area would be two units of force per square inch.

The strain of a body is defined as the ratio of the change of size of a body under stress to its original size when unstressed. A wire 100 inches in length, stretched to a length of 101 inches, has a strain of $\frac{101\text{-}100}{100} = \frac{1}{100} = 0.01$, or 1 per cent.

The ratio of stress to strain for a body such as a metal wire is always constant over a certain range of stress, the range depending on the metal. This constant ratio is called the modulus of elasticity. Three different moduli of elasticity are possible, the one of most common occurrence being that known as Young's modulus, usually represented by E, and always associated with tensile stresses.

A diagram showing the relation between the stress in a body produced by a known amount of strain is always of the form shown in Fig. 3.* In this figure the straight line shows the proportionality between stress and strain, and it is seen that at some particular value of stress the proportionality ceases. The value of stress at which this first happens is termed the proportional limit, and it may be large or small, depending on the material.

It can easily be shown that the work done† and the energy stored, per unit volume of the body in stressing it in the elastic range, that is, deforming it "elastically," are equal to half the product of the stress and the corresponding strain. This stored energy can be made to do useful work, which fact is the fundamental principle underlying the use of elastically deformed wires in orthodontics.

If a body is stressed to its proportional limit, P, the corresponding strain, e_p, is the greatest deformation the body can take without permanent change of shape. The maximum energy, recoverable in the form of useful work, that the wire can absorb in each unit of volume is $\frac{1}{2}P.e_P$ and is represented by the area of the triangle OPe_p in Fig. 3. As the stress, P, has not been exceeded, $\frac{P}{e_p} = E$, and the

*Figs. 3 and 4 have purposely been exaggerated for the sake of clarity.

†Work, in the physical sense, is defined as follows: If a force, F, moves its point of application through a distance, S, in the direction of the force, the work done, W, which equals the energy consumed, is measured by the product of F and S, that is, $W = F.S.$

energy stored in each unit volume of the body can be written as $\frac{P^2}{2E}$. The maximum energy which can be recovered in the form of useful work is, therefore, the product of $\frac{P^2}{2E}$ and the volume of the body, a quantity which may be termed the resilience of the body as a whole. The quantity $\frac{P^2}{2E}$ is termed the modulus of resilience of the material composing the body. A resilient material, therefore, is one which has a high proportional limit and a low value for Young's modulus.

The failure to distinguish between the resilience and the flexibility of a wire can cause confusion. The important facts are:

(1) The flexibility of a wire depends on the way it is supported and loaded, on the size and shape of its section, and on the value of Young's modulus of its material.

(2) The resilience of a wire depends both on the proportional limit of its material and on its flexibility.

(3) The resilience of a material depends only on the proportional limit and the value of Young's modulus. It does not in any way depend on shape.

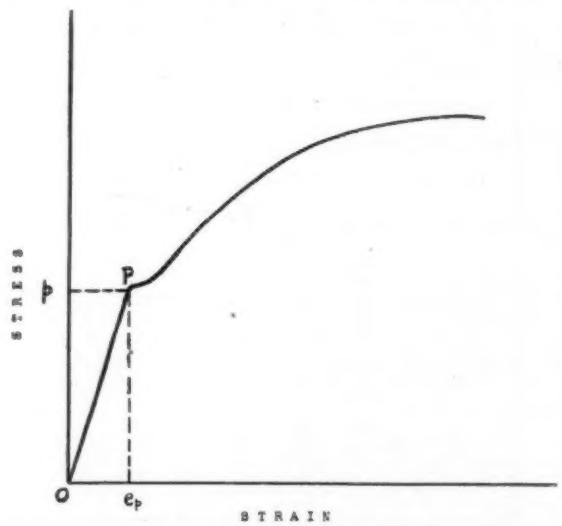

Fig. 3.—The relation between stress and associated strain for a homogeneous material.

Graphical Representation.—The bending properties of a wire can all be represented graphically. This is an instructive method of explaining the various phenomena because it presents them to the mind as a picture.

Fig. 4 shows the typical relation between the load on a wire and the deflection it produces. As the load increases, the deflection increases proportionally until point P is reached. The position of this point (corresponding to the point P in Fig. 3) depends on the proportional limit of the material of the wire. The slope of the straight line, OP, is a measure of the flexibility of the wire; the greater the slope, the less the flexibility, because a larger load is needed to produce a given deflection. Up to the point P, the line is straight, but after P

it becomes curved, showing that the proportionality between load and deflection has ceased and that an increase in load produces a larger increase in deflection than would have been the case before the point P (and the load W_P) was reached.

The resilience of the wire, that is, the maximum useful work which can be obtained from it, is given by the area of the triangle OPD_P.

Suppose that the load on the wire, having reached $W_{P'}$, is slowly removed. The wire recovers toward its position of rest, but the relation between load and deflection is not given by the same curve as previously; it is now represented approximately by the dotted line $P'XTD'$ in Fig. 4. When the load has been completely removed, the wire is left with a permanent deflection, D'. The energy lost in producing this permanent deflection is represented by the area bounded by the lines containing the points $OPP'XTD'$. The maximum work which can be obtained from the bent wire, that is, its resilience, is represented by the triangle $D'P'D_{P'}$. The flexibility of this wire is represented by the slope of the line, $D'P'$, and is about the same for the wire before being permanently bent as after (that is, the lines OP and $D'P'$ are parallel, or nearly so).

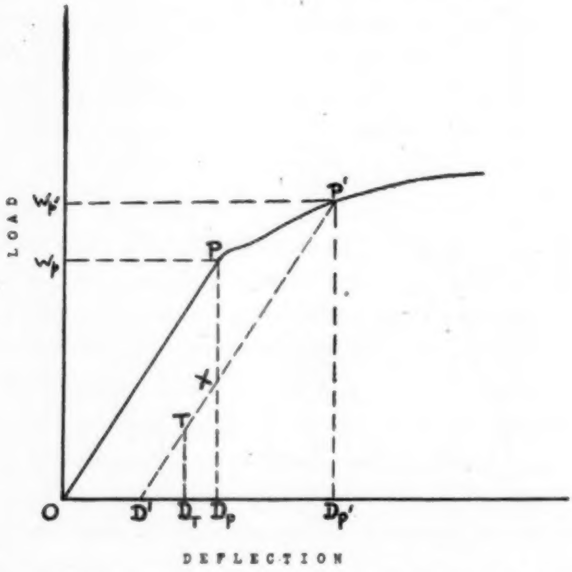

Fig. 4.—The relation between the deflection of a point on a wire and the load at the point.

It is well known that any particular tooth requires a certain minimum force to move it. Suppose that a force, F, acting on a tooth moves it a distance, S, in the direction of F. Then the work done in moving the tooth is $F.S$, and the energy stored in the arch wire is decreased by this amount. Consequently, as the tooth moves, the wire "relaxes" and exerts less force on the tooth. Ultimately, a stage is reached when the force exerted by the wire on the tooth falls below the minimum and so becomes insufficient to move it further, a condition of equilibrium being established.

The movement of a tooth by a wire can also be represented graphically. If the wire of Fig. 4 is bent before use, so that it has a permanent deflection, D', and is loaded to the point, P', by the act of fastening it to a tooth, then the tooth will be moved through some distance such as $D_{P'}D_T$. At deflection D_T, say, the force exerted by the wire is no longer sufficient to move the tooth. If we suppose that the wire was intended to move the tooth right back to D', the rest position of the wire, we see that work, represented by the area $D'TD_T$, is still to be done on the tooth. This can be effected by adjusting the wire or using a less flexible one.

Experimental Results.—In order to insure that the application of formulas (1), (1a), and (2) was justified, some measurements were made on the flexibilities of orthodontic wires of various sections, using the loading conditions of Fig. 2(*b*). The experimental results are compared with the theoretical values in Table V. The total area of cross section of the wires used and their flexibilities are expressed in terms of those of the circular wire of greatest diameter (0.0221 inch). This procedure inherently assumes that Young's modulus is the same for all wires. This may not be so and is a source of error, which, however, should not be serious because the modulus should not vary greatly among wires of the same material, in this case stainless steel.

The agreement between theory and experiment, considering the possible sources of experimental error, may be considered good.

The greatest disagreement occurs in the results for a multiple-wire arch of sixteen wires. This is probably due to the experimental difficulty of making the wires act uniformly together.

TABLE V

SECTION OF WIRE (INCH)	NUMBER OF WIRES	TOTAL AREA OF SECTION (ARBITRARY UNIT)	FLEXIBILITY (THEORETICAL) (ARBITRARY UNIT)	FLEXIBILITY (EXPERIMENTAL) (ARBITRARY UNIT)
Circular diameter:				
22.1×10^{-3}	1	1.0	1.0	1.0
20.1	1	0.89	1.3	1.2
20.5	1	0.86	1.3	1.4
16.0	1	0.52	3.6	3.3
15.1	4	1.84	1.2	1.1
6.0	16	1.18	12	15
Rectangular dimensions:				
$b = 27.9 \times 10^{-3}$				
$t = 21.0 \times 10^{-3}$	1	1.52	0.6	0.6
$b = 25.8 \times 10^{-3}$				
$t = 20.0 \times 10^{-3}$	1	1.35	0.7	0.8

Torsion.—Some use is made in orthodontics of the elastic properties of twisted wires. Unfortunately, the general theory of twisted wires is far from simple; although the forces acting in any particular case can often be analyzed, few useful conclusions can be reached which apply generally to all possible cases.

The simplest case, and the only one considered here, is that of a solid straight wire of circular section, twisted about its longitudinal axis by a couple

T* acting at one end of the wire, the other end being fixed. Let l be the length of a wire of radius r. If the angle of twist at the free end is A, then

$$A = \frac{2Tl}{N\pi r^4} = \frac{Tl}{NJ} \quad . \quad . \quad . \quad . \quad (3)$$

where $J = \frac{\pi r^4}{2}$, and N is the rigidity modulus of elasticity. The quantity N in the theory of the shear stresses and strains developed in torsion is analogous to Young's modulus, E, in the theory of pure bending. There is, in fact, a close analogy between the theory of torsion and the theory of bending. The quantity, J, is analogous to I in formula (1), and in formula (3) the product NJ, often termed the "torsional rigidity" of the wire, is analogous to EI, the "flexural rigidity" of formula (1). The couple T in (3) is analogous to the load W in (1). The formula $A = \frac{Tl}{NJ}$, in the case of torsion, is thus analogous to the formula $D = C\ \frac{Wl^3}{EI}$, in the case of bending. Continuing the analogy, we deduce at once that if the "modulus of resilience" for a material is given (for uniform stress) by $\frac{P^2}{2E}$, the "modulus of torsional resilience" of a material is given by $\frac{P_t^2}{2N}$, where P_t is the (uniform) shear stress at the elastic limit. (In the case of a wire of circular section, the intensity of shear stress is not uniform and varies as the radial distance from the axis. Simple analysis shows that the torsional resilience of the wire as a whole is $\frac{f_t^2}{4N} \cdot V$, where f_t is the maximum intensity of shear stress, which occurs on the circumference of the wire, and V is the volume of the wire.)

If we plot the magnitude of the couple acting on the wire against the resulting angle of twist, we obtain a diagram similar to Fig. 4. The load, W, is now replaced by a couple, T, and the deflection, D, by angle A. The torsional resilience of the wire as a whole, that is, the maximum energy recoverable as useful work, which can be stored by the wire, is given by the area of a triangle corresponding to OPD_P in Fig. 4, that is, by $\frac{1}{2}T_PA_P$, where T_P is the couple acting to produce the greatest angle of twist which can be obtained without passing beyond the range of elasticity. The couple, T_P, corresponds, in the case of torsion, to the load W_P in the case of bending.

In all other cases of twisting, the theory becomes complex because secondary effects are introduced. The magnitude and direction of the stresses produced in a wire which is twisted about its axis while bent are difficult to determine, though in many cases this can be done.

Summary.—The elementary theory of the bending of elastic beams is employed to investigate the mechanical properties of orthodontic arch wires.

*Two equal, parallel, and opposite forces, which cannot be replaced by any single force, are said to form a couple.

Experimental results confirm the justification of this procedure. The conclusion reached is that an arch wire should possess high flexibility combined with high resilience.

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Editorial

The American Board of Orthodontics

A BOOKLET of information including a list of certified orthodontists has been compiled by the American Board of Orthodontics for the year 1947. The information contained therein is of great interest to all orthodontists, particularly as the certification and qualifications of specialists in dentistry are so sharply in the spotlight.

The American Board of Orthodontics was created by a resolution offered by the late Martin Dewey at the Twenty-eighth Annual Meeting of the American Society of Orthodontists, held in Estes Park, Colorado, July 16 to 19, 1929. In retrospect, it is now interesting to review the resolution that was passed and thereby made it possible to create such a body:

"RESOLVED: That the American Society of Orthodontists create and sponsor an organization to be known as The American Board of Orthodontics, which shall consist of seven men of unquestionable and outstanding reputation and accomplishment in the science of orthodontics, who shall be appointed by the executive committee and elected by the general assembly at large—one to serve for a period of one year, one to serve for a period of two years, one to serve for a period of three years, one to serve for a period of four years, one to serve for a period of five years, one to serve for a period of six years, and one to serve for a period of seven years; and one to be elected annually thereafter to serve for a period of seven years. The nominations made by the executive committee shall not be voted upon until the following day thereafter. Three-fourths of the votes cast shall be necessary to elect a nominee a member of the American Board of Orthodontics.

"The Board shall organize and make rules regarding the requirements for examination of candidates for the granting of certificates of fitness, and to make such other rules and regulations as it may deem necessary for the proper functioning of the Board."

Under the head of the purposes of the organization is found the following:

"First. To stimulate and keep alive the spirit of research and self-improvement among students and practitioners of orthodontics.

"Second. To establish the competence of specialists to practice orthodontics.

"Third. To assist in the establishment and maintenance of adequate standards of instruction in orthodontics in dental schools and to prepare a list of such competent sources of instruction.

"Fourth. To arrange, control, and conduct examinations for the purpose of testing the qualifications of orthodontists and to confer certificates upon those who meet the established requirements of the Board."

The Albert H. Ketcham Memorial was later established by the American Board of Orthodontics in collaboration with the American Association of Orthodontists. This was done in 1936, in order to commemorate Dr. Ketcham's achievements and to serve as an inspiration to the advancement of orthodontics among its workers.

The Albert H. Ketcham Memorial consists of an illuminated parchment, appropriately inscribed, awarded annually to an orthodontist or some other person who, in the judgment of the award committee, has made a notable contribution to the science and art of orthodontics during the current year or some previous period.

The Ketcham Memorial has been awarded in the past to the following orthodontists:

1937	Dr. John V. Mershon, Philadelphia, Pennsylvania
1938	Dr. Alfred P. Rogers, Boston, Massachusetts
1939	Dr. Milo Hellman, New York, New York
1940	Dr. George W. Grieve, Toronto, Canada
1941	Dr. Frederic B. Noyes, Chicago, Illinois
1942	Dr. Harry E. Kelsey, Baltimore, Maryland
1944	Dr. Holly Broadbent, Cleveland, Ohio
1946	Dr. Raymond C. Willett, Peoria, Illinois

There can be no doubt now that the American Board of Orthodontics is making a great contribution to the advance of the specialty. It has taken a long period of years and tremendous sacrifice of time and effort on the part of those who are and have been members of the board. Its influence in orthodontics is now being sharply felt as never before and the board should enjoy the enthusiastic cooperation of every orthodontist practicing in America because the board may prove to be the greatest bulwark that orthodontics has ever created, particularly when judgment day arrives as now seems quite possible, when the American Dental Association will be the final judge as to the question of when is a specialist not a specialist in any department of dentistry.

H. C. P.

Resolutions of the Southwestern Society of Orthodontists

We, the Board of Directors of the Southwestern Society of Orthodontists, in regular session on July 20, 1947, protest much of the action taken by the Council on Dental Education in assuming jurisdiction over the educational requirements for the specialties, with such extensive demands that they will discourage dentists from attempting to qualify and thereby create a shortage.

We further protest the declaration of the Council that legislation covering official licensure of the specialties will no longer be needed under this proposed plan, when we are of the opinion that the states should be encouraged to adopt it on a harmonious plane with the basic courses of training leading to certification now being provided in the dental colleges. We are of the opinion the basic training courses of one to two years should be the minimum requirements on which dependence may be placed to win the profession's and the public's recognition of acceptance. Two of the several states within the jurisdiction of the Southwestern Society of Orthodontists are now operating most successfully under this plan and another is planning to adopt it.

We are furthermore of the opinion that the specialty groups should provide and maintain certification systems of their own choosing on an independent basis to supplement the terms of basic training and official licensure, as an additional incentive and reward for achievement.

We recognize the need for expansion in both the official and unofficial systems of certification, but are of the opinion they should be coordinated along more feasible lines than the present plans of the Council on Dental Education now provide.

We suggest, therefore, that the plans of the Council on the subject be given additional study before being fully adopted.

BOARD OF DIRECTORS
SOUTHWESTERN SOCIETY OF ORTHODONTISTS

Department of Orthodontic Abstracts and Reviews

Edited by

DR. J. A. SALZMANN, NEW YORK CITY

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The 1946 Year Book of Dentistry: Edited by Lester Cahn, D.D.S., George W. Wilson, D.D.S., Carl W. Waldron, M.D., D.D.S., Stanley D. Tylman, D.D.S., M.S., George R. Moore, D.D.S., M.S. Consulting Editor, Howard C. Miller, D.D.S., L.L.D. Illustrated, Pp. 736. Price $3.75. The Year Book Publishers, Chicago, 1947.

The present volume, as was true in previous years, provides a report on the contributions to current dental literature. Occasionally, one feels that more selectivity could be exercised in the choice of review material. The fact that an article receives publication is not always sufficient reason for including it in a yearbook. On the whole, however, the material has been well chosen and is well distributed among the various subdivisions of dentistry.

Cahn presents a review on the use of penicillin in dental practice to prevent and to combat infection. Case reports indicating the specific uses of penicillin are presented. The section on oral pathology contains a number of interesting illustrations of various oral diseases. Throughout the volume the quality and quantity of the illustrations have been greatly improved. The criterion has been followed which relates the utility of the illustrations to the fuller understanding of the article in which they are used.

Dentistry for children is presented as a separate section under Operative Dentistry. Roentgenography of the teeth of children is described in some detail by various authors. The use of silver nitrate is explained along histologic grounds and the general considerations of reduction of pain in operative dentistry are discussed.

It is interesting to note that the editor of the section on prosthetic dentistry feels that denture reliners have so far proved unsatisfactory. This is additional reason why dentistry should oppose the sale of these products directly to the public.

Moore, in the section on orthodontics, presents articles dealing with genetic factors in the etiology of malocclusion. With regard to preventive orthodontics, there seem to have been no new contributions during the past year. There is a greater need for a manual of procedure that would tell the dentist in general practice what to do for the child patient to intercept or abort threatening malocclusion. Many articles dealing with diagnosis and classification of malocclusion including the question of extractions are given detailed discussion.

The publishers of *The Year Book of Dentistry* are rendering a valuable service to the profession by making available in one volume an annual encyclopedia of dental art and sciences. The book can be enthusiastically recommended to the student and practitioner.

Restorative Dentistry. A Clinical Photographic Presentation: By Jerome M. Schweitzer, B.S., D.D.S., New York City. With 1,014 text illustrations. Price $15.00. The C. V. Mosby Company, St. Louis, 1947.

Schweitzer introduces his work with a consideration of anterior one-tooth gold fixed bridges. This type of restoration has long been a major problem in tooth replacement. Evidently the author is in agreement with the old Chinese proverb that one picture is worth a thousand words. He uses a minimum of words and a maximum of illustrations. For example, in the construction of the pinledge which Schweitzer considers desirable when internal retention is necessary, the various steps are shown in sequence from the prepared tooth to the insertion of the bridge. The different types of anterior bridges discussed include the use of plastics and porcelain. Practicing dentists will find here examples of all kinds of anterior bridges which should aid them in perfecting their techniques for specific cases in their practice. Construction of appliances before the removal of anterior teeth is discussed.

Due consideration is given to occlusion in a section devoted to posterior bridgework. The condition of the periodontal tissues is taken into consideration in each instance as is the stability of the abutment teeth. The restoring vertical dimension and the treatment of closed-bite cases are fully discussed. It appears that the shape of the pontic should not be based on the arbitrary discretion of the operator. Indications and contraindications are provided for the use of various types of pontics and the techniques for their construction are described.

It is worthy of note that the replacement of single missing teeth which has been generally neglected by dentists is here given major consideration. This is, of course, as it should be. The practicing dentist is daily faced with ruined mouths which were started on the downgrade by the failure of some dentist to provide a bridge for a space after a tooth had been extracted. This phase of dental neglect, which can be largely attributed to the dentist himself, has never received the consideration due it.

Chapter III is largely devoted to discussion of bilateral removable bridgework, including pressure saddles, lingual bars, and indirect retention, and here as elsewhere the techniques are demonstrated by excellent photographs. Nonprecious metal restorations are discussed especially in connection with occlusal reconstruction. Criteria are provided for planning occlusal reconstruction. The author warns, "so-called occlusal reconstruction is an attempt to bring about a harmonious relationship of the teeth, the condyles and the mouth." Too much should not be promised the patient. On the other hand, the patient should be made acquainted with the magnitude and involvements of the work to be undertaken. Methods of obtaining centric relation by means of a central-bearing instrument and a checkbite are fully illustrated. This is a basic procedure on which the entire art of occlusal restoration rests. Full denture construction and immediate dentures are presented in detail and fully illustrated.

This is a pictorial book which will be found valuable by practicing dentists who wish to improve and upgrade their everyday restorative dental service.

Prevention of Congenital Malformation: Queries and Minor Notes, J. A. M. A. **132**: 674, November 16, 1946.

To the Editor.—Please discuss prevention treatment for congenital malformations of the developing fetus in utero.

M.D., Lynden, Washington.

Answer.—According to D. P. Murphy (***Congenital Malformations: A Study of Parental Characteristics With Special Reference to the Reproductive Process,*** Philadelphia, University of Pennsylvania Press, 1940, p. 97), the factors responsible for the production of congenital defects appear to be present in either the sperm or the egg cell prior to the time of fertilization. If this opinion is correct, a certain minimal number of congenitally malformed individuals will continue to be born at a more or less constant rate.

Two factors under human control can influence the birth rate of defective offspring. One of these is parental age, but only after 30 years of age does this factor assume any role in influencing the birth rate of congenitally malformed children. After this age there is a decided increase in the birth rate of defective offspring. For example, after the mother is 40 years of age, the birth rate of congenitally malformed children is approximately three times the rate which is observed when the mother is less than 30 years old.

The second factor under human control which can influence the birth rate of malformed children is the previous birth of a malformed child in a family. In the general population, a gross malformation, regardless of how slight, occurs with a frequency of about 1 to 200 live births. In contrast to this frequency, among the offspring of the parents of a malformed child, born subsequent to its birth, another malformed child will be born once in every eight births. In other words, the parents of a malformed child are extremely likely to have another defective offspring.

Another factor which may influence congenital malformations is an attack of rubella in the mother during the first trimester of pregnancy. Avoidance of exposure to rubella during this period of pregnancy is therefore desirable.

There appears to be no way known at present to reduce the birth rate of congenitally malformed children except to follow the two suggestions mentioned, namely to limit reproduction to the years before 30 years of age, and for the parents of malformed children to have no more children.

News and Notes

American Association of Orthodontists

The next meeting of the American Association of Orthodontists will be held at the Neil House on State House Square, Columbus, Ohio, April 27, 28, and 29, 1948. Members of the American Dental Association are invited to attend this meeting. Proper credentials should be obtained in advance from the secretary of the American Association of Orthodontists, Dr. Max E. Ernst, 1250 Lowry Medical Arts Building, St. Paul 2, Minnesota, or from the secretary of a constituent society.

Great Lakes Society of Orthodontists

The eighteenth annual meeting of the Great Lakes Society of Orthodontists will be held Oct. 27 and 28, 1947, at the Royal York Hotel, Toronto, Canada.

The two-day meeting will feature the following essayists:

Dr. Wendell Wylie, San Francisco, California.

Dr. W. B. Downs, Chicago, Illinois.

Dr. Andrew Jackson, Philadelphia, Pennsylvania.

Northeastern Society of Orthodontists

The next meeting of the Northeastern Society of Orthodontists (formerly New York Society of Orthodontists) will be held at the Waldorf-Astoria Hotel, New York, on Monday and Tuesday, Nov. 10 and 11, 1947.

Seminar for the Study and Practice of Dental Medicine

The fourth annual seminar for the study and practice of dental medicine will be held at the Ahwahnee Hotel in Josemite, California, on Oct. 19 to 24, 1947.

Prize Essay Contest, American Association of Orthodontists

Eligibility.—Any member of the American Association of Orthodontists, any person affiliated with a recognized institution in the field of dentistry and/or allied or affiliated institutions or fields as a teacher, researcher, undergraduate, or graduate student shall be eligible to enter the competition.

Character of Essay.—Each essay submitted must represent an original investigation and contain some significant material of value to the art or science of orthodontics.

Prize.—A cash prize of $500.00 is offered for the essay judged to be the winner. The committee, however, reserves the right to omit the award if in its judgment none of the entries is considered to be worthy. Honorable mention will be awarded to those authors taking second and third place. The first three papers will become the property of the American Society of Orthodontists and will be published. All other essays will be returned.

Specifications.—All essays must be typewritten on 8½ by 11 white paper, double spaced, with 1-inch margins, and composed in good English. Three copies of each paper, complete with illustrations, bibliography, tables, charts, etc., must be submitted. The name

and address of the author must not appear in the essay. It should be typed on a separate sheet of paper and clipped to the essay. This same sheet should bear a brief biographical sketch of the author, setting forth his or her dental and/or orthodontic or other trainings, present activity and status (practitioner, teacher, student, research worker, etc.).

Presentation.—The author of the winning essay will be invited to present it at the meeting of the American Association of Orthodontists to be held at Columbus, Ohio, in April, 1948.

Final Submission Date.—No essay will be considered for this competition unless received in triplicate by the Chairman of the Research Committee, American Association of Orthodontists, 30 North Michigan Avenue, Chicago 2, Illinois, on or before Jan. 15, 1948.

ALLAN G. BRODIE, CHAIRMAN, RESEARCH COMMITTEE.

Notes of Interest

Edward A. Cheney, D.D.S., M.S., wishes to announce the opening of offices at 320 West Ottawa Street, Lansing, Michigan, practice limited to orthodontics.

Dr. J. M. Loughridge, orthodontist, announces the removal of his office to Suite 216 Medico Dental Building, Eleventh and L Streets, Sacramento, California.

William R. Root, D.D.S., announces the removal of his office to Suite 733, Brisbane Building, 403 Main Street, Buffalo 3, New York, practice limited to orthodontics.

Dr. Raymond C. Sheridan announces that after August 1 he will be relocated at 59 South Orange Avenue, South Orange, New Jersey, practice limited to orthodontics.

Dr. Howard Yost announces the association of Dr. James E. Weesner, recently returned from the Armed Forces, in practice limited to orthodontics at 404 First National Bank Building, Grand Island, Nebraska.

Dr. Carl Zeisse announces the opening of his office at 255 South 17th Street, Medical Tower Building, Philadelphia 3, Pennsylvania, practice limited to orthodontics.

OFFICERS OF ORTHODONTIC SOCIETIES

The AMERICAN JOURNAL OF ORTHODONTICS AND ORAL SURGERY is the official publication of the American Association of Orthodontists and the following component societies. The editorial board of the AMERICAN JOURNAL OF ORTHODONTICS AND ORAL SURGERY is composed of a representative of each one of the component societies of the American Association of Orthodontists.

American Association of Orthodontists

President, Earl G. Jones - - - - - - - - - - - 185 East State St., Columbus, Ohio
President-Elect, Lowrie J. Porter - - - - - - - - - 41 East 57th St., New York, N. Y.
Vice-President, G. Vernon Fisk - - - - - - 818 Medical Arts Bldg., Toronto, Ont., Can.
Secretary-Treasurer, Max E. Ernst - - - 1250 Lowry Medical Arts Bldg., St. Paul, Minn.

Central Section of the American Association of Orthodontists

President, Ralph G. Bengston - - - - - - - - - 25 E. Washington St., Chicago, Ill.
Secretary-Treasurer, Earl E. Shepard - - - - - - - - - - 4500 Olive St., St. Louis, Mo.

Great Lakes Society of Orthodontists

President, S. Stuart Crouch - - - - - - - - - - 86 W. Bloor St., Toronto, Ont., Can.
Secretary-Treasurer, C. Edward Martinek - - - - - - 661 Fisher Bldg., Detroit, Mich.

Northeastern Society of Orthodontists

President, John W. Ross - - - - - - - - - - - - - 1520 Spruce St., Philadelphia, Pa.
Secretary-Treasurer, Oscar Jacobson - - - - - - - - - 35 W. 81st St., New York, N. Y.

Pacific Coast Society of Orthodontists

President, S. B. Hoskins - - - - - - - - - - - Medical Dental Bldg., Portland, Ore.
Secretary-Treasurer, Frederick T. West - - - - - 870 Market St., San Francisco, Calif.

Rocky Mountain Society of Orthodontists

President, Henry F. Hoffman - - - - - - - - - - 700 Majestic Bldg., Denver, Colo.
Secretary-Treasurer, Harry V. Banks - - - - - - - - - 1550 Lincoln St., Denver, Colo.

Southern Society of Orthodontists

President, Neil J. Leonard - - - - - - - - - - - - - Exchange Bldg., Memphis, Tenn.
Secretary, Leland T. Daniel - - - - - - - - - - - - - - American Bldg., Orlando, Fla.

Southwestern Society of Orthodontists

President, R. E. Olson - - - - - - - - - - - - - - - - 712 Bitting Bldg., Wichita, Kan.
Secretary-Treasurer, Marion A. Flesher - - - Medical Arts Bldg., Oklahoma City, Okla.

American Board of Orthodontics

President, Oliver W. White - - - - - - - - - 213 David Whitney Bldg., Detroit, Mich.
Vice-President, Joseph D. Eby - - - - - - - - - - 121 E. 60th St., New York, N. Y.
Secretary, Bernard G. deVries - - - - - - - - Medical Arts Bldg., Minneapolis, Minn.
Treasurer, James A. Burrill - - - - - - - - - - 25 E. Washington St., Chicago, Ill.
James D. McCoy - - - - - - - - - 3839 Wilshire Blvd., Los Angeles, Calif.
Stephen C. Hopkins - - - - - - - - 1726 Eye St., N.W., Washington, D. C.
Reuben E. Olson - - - - - - - - - - - - - - 712 Bitting Bldg., Wichita, Kan.

In the January issue each year, the AMERICAN JOURNAL OF ORTHODONTICS AND ORAL SURGERY will publish a list of all of the orthodontic societies in the world of which it has any record. In addition to this, it will publish the names and addresses of the officers of such societies.